A NOVEL ENVIRONMENTAL FRAMEWORK FOR THE INDUSTRIAL PARKS IN THE SOUTH WESTERN TOWNSHIP, GAUTENG: A STUDY ON CLEANER PRODUCTION.

By

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Declaration

I, Takalani Nemarumane, declare that this thesis on, A novel environmental framework for the Industrial Parks in the South Western Township, Gauteng: A study on cleaner production, which I hereby submit for a PhD Degree in Engineering Management at the University of Johannesburg, Faculty of Engineering and the Built Environment, School of Engineering Management is my own original work and has not been previously submitted in any institution.

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Abstract

South Africa's Industrial Parks are engines of the country's economy, yet they also are major sources of pollution and the current process for approving enterprises and ensuring that they meet environmental standards is ineffective. The facilities that have been built to mitigate pollution in the parks are not adequately used. Economic Industrial Parks (EIP) reflect the harmonisation of financial development and the protection of the environmental. Member-businesses pursue greater environmental, economic, and social performance through partnerships in handling environmental and resource matters. Eco-industrial parks (EIP) have not been developed in the South Western Township (Soweto) of the Gauteng province in South Africa, and furthermore, Informal EIPs have not been an area of focus for research thus creating a room for application.

The purpose of the research is to develop an integrated environmental plan and framework that is focused on industrial Parks in the Soweto. The objective of the framework is to positively contribute to an eco-friendly environment, and thus in turn improving the quality of life for residents, workers and decision makers impacted by the industrial parks. The literature review found that there are various frameworks that exist internationally, but none of them are customised to South Africa or Soweto. The literature review also clarified that there are environmental, economic and social benefits in developing Eco-industrial parks. The development of a framework for and Eco-industrial park in Soweto is necessary to sustain the eco-system. This indicated that the objective of the study to develop an Eco-industrial park framework is valid and necessary.

The techniques used to gather the data, included the design and distribution of the questionnaire, the use of factor analysis and its application, and addressed how the gaps identified in the critical assessment of literature are addressed.

The study analysed the raw materials that the industrial parks in Soweto use and the waste that is produced in the Industrial Parks. It was found that that the Industrial Parks have challenges in waste management and are not informed in terms of waste management techniques that are available for them. It was also found that the businesses in the industrial park are keen on selling waste, but fewer on buying waste from other businesses.

The study further found that there are negative environmental impacts caused by Industrial Parks, and that there that there is an appetite for developing an EIP in Soweto. The factors identified, through factor and reliability analysis, were found to be valid and acceptable, which means that these factors can be used to derive an Eco-industrial park framework.

The study developed a framework for Eco-industrial parks in Soweto based on four principles namely; the Organisational principle, Development principle, Sustainability principle and Waste Monitoring and Control principle. Each of these principles consist of factors and practices that when applied would add value to the development of Eco-industrial parks. The successful application of the Organisational principle leads to stakeholder support, whereas the successful application of the Development principle would lead to business innovation and development. Furthermore, the successful application of the Sustainability principle would lead to business efficiency training and learning, while the successful application of the Waste monitoring and Control principle would lead to effective waste administration and supervision. All these principles applied together should lead to the successful development of Eco-industrial parks. The focus of Eco-industrial parks is to ensure that the products and services produced in the Parks are environmentally friendly from the product manufacturing phase to the product disposal phase. This framework introduces the concept of businesses working together in a network, through process sharing, information sharing, and through joint waste management techniques. This concept allows the parks to innovate and develop their processes and products and thus creating a successful Eco-industrial park.

Based on the objectives and sub-objectives of the study, the study identified the environmental impacts if the Industrial parks by classifying the raw materials and the waste materials produced by the parks. These materials were further analysed to identify the impact of each on the environment. The study also found that the development of Eco-industrial parks was practical in Soweto as the location of the current Industrial Parks was favourable to develop them into Eco-industrial parks, and the keenness of the current Industrial Park to sell and buy waste from each other in the Industrial Park network. The study further developed a detailed, viable framework that aims to be a guideline on how to develop the current Industrial Parks into Eco-industrial parks locally. Lastly, the study found that the benefits of developing an Eco-industrial park in Soweto, would allow businesses within the Industrial Parks network to collaborate with each other and with other stakeholders outside the industrial Park network. This will allow the businesses to share processes and gain expertise from each other.

These collaborations with also be profitable to the businesses as they will be able to buy their raw materials at lower prices while also selling parts of their materials. The ultimate benefit for developing though, Eco-industrial parks would be preserving the environment. That is a key principle of the enterprise.

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Glossary of Acronyms and Terms

Definitions
Industrial Park (IP): area zoned and planned for the purpose of industrial development.
Eco-industrial park (EIP): Member businesses seeking enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues.
Cleaner Production (CP): the production of products using fewer resources with the aim of sustaining the environment.
South Western Township (Soweto): A township in based on the south of the Gauteng province in South Africa.
Environmental Framework: A detailed plan that aims at preserving the environment while maintaining profitable business operations.
Eco-friendly: substances, products and processes that do not cause any harm to the environment.
Eco-system: The interaction of various factors in their original habitat.
Product-Life Cycle: Process a product undergoes from production, to consumption.
Waste Management: the reduction or elimination of waste that is disposed with the aim of preserving the environment.
By-Products: Secondary products that result from the production of primary products.
Pollution: The release of harmful substances into the environment.
Raw Materials: Inputs used to manufacture a product.
Manufacturing: The production of tangible products.
Service: The production of intangible products.
Consumption: The usage of a specific resource.
Business Networks: Businesses that operate from a single industrial park
Quality of life: the level of satisfaction in terms of basic needs, esteem needs, Social and Security needs.
United Nations Industrial Development Organisation (UNIDO): An organisation that aims to promote industrial development in developing countries.
United Nations Environment Programme (UNEP): An organisation responsible for assisting developing countries to develop environmental policies and frameworks.

Environmental Sustainability: The maintenance and mitigation of the environment depletion.
Collaboration: association and partnering between businesses and institutions.
Appetite: Interest and opportunity for development and creation.
Informal sector: Businesses that are not registered as Small, Medium or Micro Enterprises.
Industrial Symbiosis: a concept in which one business' waste material is a raw material for another business.
Economy: a country's supply of money, including its production and consumption of its products.
Innovation: the development of new ideas, products and services.
Strengths, Weaknesses, Opportunities and Strengths (SWOT) analysis: Assessing the internal and external factors of a business to understand a holistic view of the impact of its operations.
Social Factors: issues that affect the communities' attitudes, behaviours, values and lifestyles.
Critical Assessment: Analysis of literature over a specific period, under a defined topic with the use of defined headings.
Eco-Efficiency: The production of quality products and services while limiting the negative impacts on the environment.

1. INTRODUCTION

The rapid human population increase and expansion of resource–consumption, combined with industrialization, urbanization, mobilization, agricultural intensification and resource intensive lifestyles are together contributing to worldwide environmental, social and economic crisis. The list of environmental damage is endless, from climate changes causing life threatening natural disasters (e.g. floods, droughts, etc.) to species extinction and the destruction of natural ecosystems (Van der Ryn and Calthorpe , 2000). Social and economic problems such as inequity in resource distribution and access to health care are also threatening the survival of human beings. In this context, there is need to consider development more carefully and adopt a holistic response to minimize harmful social, economic and environmental effects. This in turn will maintain the health of the ecosystems of which human beings are part (Geng , Haight and Zhu , 2005). In this thesis the management of Industrial Parks is seen in this context.

An Industrial Park (also known as industrial estate or trading estate) is an area zoned and planned for the purpose of industrial development. An Industrial Park can be thought of as a business park or office park, which has offices and light industries, rather than heavy industries (Lowe, 1997).
It is a percentage of a city that is zoned for commercial use, rather than residential use (Lowe, 1997). Business parks may additionally incorporate oil refineries, ports, warehouses, distribution centres, chemical plants, plastics manufacturers, airports, food and beverage processors, and metallic producers (Lowe, 1997). Industrial Parks development provide tax incentives for companies to locate there, along with tax increment financing (Lowe, 1997).

South Africa's Industrial Parks are engines of the country's economy, yet they also are major sources of pollution, and the process for approving enterprises and ensuring that they meet environmental standards is ineffective. The facilities that have been built to mitigate pollution in the parks are not used adequately. Based on Rogerson's (1995) analysis land resources also are being wasted furthermore, disputes over environmental standards are frequent, and regulations often are not enforced.

Of the 18 Industrial Parks investigated, 13 have supporting wastewater treatment plant. However, these facilities are used only occasionally, and in some cases, they are never used. Industrial Parks need to restore their structure base to meet increasing social, financial and environmental difficulties.

Long term planning is necessary to address the natural impacts of economic development at an acceptable level. In this context of environmental pollution and pressure on continuous performance, the development of eco-industrial parks provides effective solutions for industrial development. Therefore, it can be concluded that sustainable development is not just a concept that should be pressed by environmentalists and policy makers as indicated in Figure 1.1 below, nonetheless should be incorporated by industries and the commercial societies (Haggar, 2007). If social, ecological and economic factors are managed adequately, their intersection is system development that is bearable, viable, equitable and most importantly, sustainable (See Figure 1.1 below).

Figure 1.1: Three pillars of System Development (Haggar, 2007)

1.1 Background of Industrial Parks in Soweto, Gauteng Province.

Soweto produces millions of tons of waste per year. This is mostly industrial waste from the processing of natural resources into industrial products, and the rest is municipal waste (Samson 2015). A huge percentage of this waste is either incinerated or dumped in landfills. Municipalities and industry are thus in a difficult position, challenging them to find waste management practices that are an alternative to incineration.

Waste reduction and minimisation efforts need to be increased and the problem clearly calls for initiating an industrial ecology approach (Samson 2015). Due to limited resources, some companies are pushing to build in prohibited areas and when advised not to do so, they might well not understand the underlying reason (Blight 2008). Soweto annually consumes a million tons of natural resources, and imports millions of tons from overseas. There is therefore, a wide-ranging fear that as resources and area for landfill become rarer, while waste disposal charges surge, financial development may be disadvantaged by rising resource inefficiencies (Blight 2008). Soweto produced almost 108 million tons of waste in 2011, of the produced waste, 97 million was disposed of in landfills. 59 million tons of the produced waste was labelled as general waste and 49 million tons was uncategorized and hazardous waste. 10% of all the waste produced in Soweto was recycled (CSIR and COWI, 2012). This is mostly industrial waste from the processing of natural resources into industrial products, and the rest was municipal waste. A huge percentage of the municipal waste was either incinerated or dumped in landfills.

Municipalities and industries are thus in a difficult position, with challenges to find waste management practices alternative to incineration. Waste reduction and minimization efforts need to be increased, and the problem clearly calls for further initiatives in an industrial ecology approach (Samson 2015).

Currently in Soweto, environmental protection is ignored at the expense of economic development (Haggar, 2007). With sustainable development and design this does not have to be the case. Sustainable development looks to simultaneously lowering costs and improving the environment. Therefore, it can be concluded that sustainable development isn't just a concept that should be pushed by environmentalists and policy makers, but should be embraced by industries, the business community, and society as well (Haggar, 2007).

Economic Industrial Parks (EIP) reflect the synchronisation of economic growth and environmental protection and is defined as "a community of manufacturing and service businesses located together on a common property." (Lowe, 2001) Member businesses look to enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimizing its own performance (Lowe, 2001).

The construction of EIPs is highly popular; however, the evaluation of the viability of industrial parks is a poorly documented. Literature states a number of studies on the construction of EIPs, however, these fail to interrelate with infrastructure development in the energy system, rather they focus on direct energy, environmental influences, economic and social impacts (Lowe, 2001).

EIPs and low-carbon industrial parks offer different benefits to the users. EIPs adhere to the concept that any industrial park experiment should take a different approach. This then means that, the assessment of the sustainability of industrial parks should be demonstrated through the ecological balance, economic and resource conservation (Lowe, 2001).

1.2 The research problem and its significance

Industrial Parks are a cardinal unit of economic development and should play a key role in the national development strategies of South Africa. Industrial Parks have proven to be irreplaceable where economic development is concerned. Stiglitz (2013) posits that there is a mismanagement of Industrial Parks in South Africa, which is evident in the depleting environment in terms of resources sustainability. It is thus essential to assess to the possibility for the development of eco-Industrial Parks to improve the eco-system, and also to provide a better quality of life for residents and communities impacted by these (Samson 2015).

1.3 The purpose of the research

The purpose of the research is to develop an integrated environmental plan and framework that is focused on Industrial Parks in the South-Western Township in the Gauteng province. The objective of the framework is to positively contribute to the eco-friendly environment, and thus in-turn improving the quality of life for residents, workers and decision makers impacted by these.

1.4 Scope of the research

The study will focus on the manufacturing parks in the South-Western Township in the Gauteng province. The manufacturing organisations will include electronic, food, glass, maintenance, metal, textile, plastic, rubber, wood, chemicals and construction.

The study will not focus on transport and logistics organisations, information technology services, and security organisations within the industrial parks, as these are service organisations that do not have a tangible product for the current analysis.

1.5 Research objectives

To develop a framework that will assist in the development of Eco-industrial parks in Soweto.

Sub-objectives

- To assess current environmental framework through a literature review.
- To evaluate current environmental impacts of Industrial Parks in Soweto.
  To test appetite for Eco-industrial parks in Soweto.
- To develop a novel Eco-industrial park framework for Soweto.
- To assess potential benefits of developing Eco-industrial parks in Soweto.

1.6 Contribution of the study

South Africa currently does not have Eco-industrial parks; therefore, the study will serve as a base for the possible development and implementation of Eco-industrial parks. The study will further provide recommendations that are specific to South Africa, thus adding to the body of local knowledge.

The method used to gather data will further provide a detailed analysis of the type of Industrial Parks that exist in the South-Western Township, the processes involved and further provide a model on how to implement Eco-industrial parks in South Africa.

1.7 Statement of the main problem (research question and sub-questions)

How can an integrated environmental plan be implemented in Soweto Industrial Parks to improve the quality of life of workers and residents and at the same time contribute to the eco-friendly environment?

Sub-questions:

- What are the environmental impacts of the Industrial Parks?
- How feasible is the development of Eco-industrial parks in Soweto?
- Is there an appetite for eco-industrial park in Soweto?
- How can an Eco-industrial park framework be developed in Soweto?
- Is there an appetite for Eco-industrial parks in Soweto?

1.8 Research process and methods

Philosophy: An Objective Epistemology will be applied in the study. The researcher will not interfere with the various organisations within the observed and surveyed parks. Data will be collected and analysed without the application of the researcher's biases. Results and recommendations will be compiled based on the data collected and will reflect the nature of Industrial Parks under scrutiny.
The data collected will be used to explain the current reality in the Industrial Parks, and predict and attempt to suggest the future of these Industrial Parks.

Approach: The study is Inductive as it aims at assessing the Industrial Parks and implementing the Eco-industrial parks approach to reduce the negative environmental and social impacts. The study will explore the development and implementation of Eco-industrial parks in Soweto. According to Lodico et.al (2010), inductive research is an approach in which the researcher describes a phenomenon based on observation, this is illustrated in Figure 1.2 below. The study will observe what is currently practised at the various Industrial Parks, and thus create a reasoned approach based on the observations, and an analysis which will the lead to the development of recommendations.

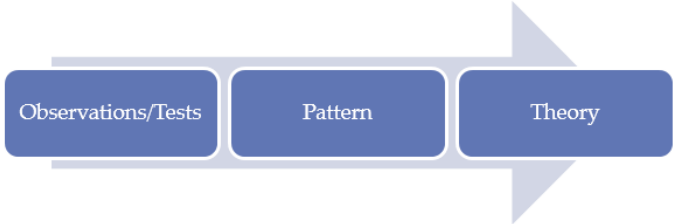

Figure 1.2: Inductive research approach. (Lodico, et.al. 2010)

Strategy: Action research will be applied. This is a form of self-reflective enquiry undertaken by participants in serial situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of practices and the situations in which these practices are carried out (Lodico, et.al. 2010). Industrial Parks that will be surveyed include electronics, food, glass, maintenance, metal, textile, plastic, rubber, wood, chemicals and construction. Transportation and logistics organisations will not form part of the survey as they do not have tangible products for assessment, and hence beyond the scope of present study.

Choices: A Mixed Method research approach will be used in the study. Mixed Methods research is a method for conducting research that involves collecting, analysing, and integrating quantitative and qualitative research in a single study. This is illustrated in Figure 1.3. The purpose of this form of research is that both qualitative and quantitative research, in combination, provide for a better understanding of a research problem and issue than either research approach alone (Lodico, et.al 2010).

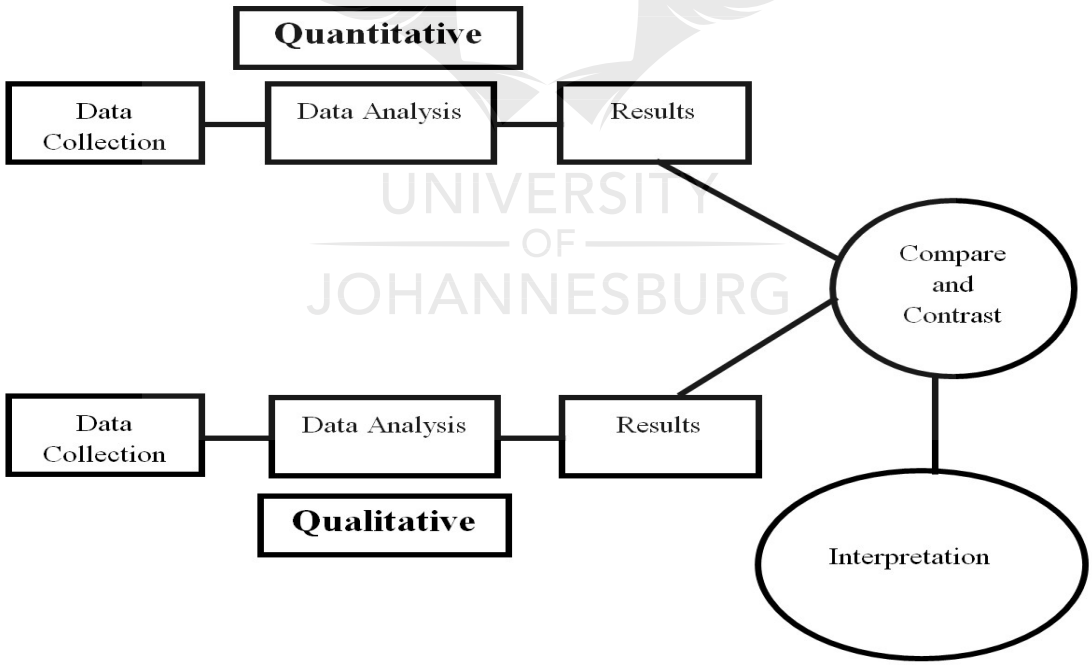

Figure 1.3: Mixed Method research design approach (Creswell 2012)

Time zones: The study will be cross-sectional. This means that it the environment used for the assessment and implementation of Eco-industrial parks will not be manipulated to suit the study. The factors that will be analysed and assessed for this study will only be those that have an impact on the environment ecology. The study will not take into consideration factors that do not have a direct impact on the environment and quality of life for the workers and communities affected by the Industrial Parks in Soweto.

Direct observations will be conducted as a form of additional data gathering technique. This tool will assist in gathering data about the type of environment that the Industrial Parks operate in and the social impact of these industries.

Techniques and approaches: Questionnaires will be used to for the workers in the Industrial Parks and the surrounding communities. These will be the main tool of primary data gathering. An adequate sample of Industrial Parks will be identified through the assistance of STATKON, and questionnaires will then be distributed. The analysis of questionnaires will be conducted by STATKON and the results will be discussed in the report. The analysis of data will be conducted through the Statistical Package for Social Scientists (SPSS).

This system allows the researcher to include the following:

- Electronically store questionnaire data in a spreadsheet table like that of Microsoft Excel.
- Generate basic descriptive statistical data for question responses, such as frequency counts of closed questions and distribution of multiple-choice question responses.
- Create graphical presentations of questionnaire data for reporting, presentations and publications.
- Explore relationships between responses to different questions and collating open question responses.

The managers and supervisors in the Industrial Parks will be interviewed. The answers given will be mostly used as recommendations. The interviews will assist in assessing the managers' perceptions and attitudes towards the Industrial Parks and its impacts. Community stakeholders will also be interviewed to assess their perceptions of how the Industrial Parks impact their communities.

1.8.1 **Data Analysis**

The interpretation, presentation, and organization of data will be done through the application of statistics. Statistics is concerned with the preparation of data gathering for the analyses and experimentations. Two types of analysis methods will be used, namely the descriptive and the inferential statistics.

Descriptive statistics deals with two arrangements of properties of a test or populace. The focal propensity (or area) looks to describe the appropriation's focal value, and portrays the degree to which individuals from the dissemination leave from its centre and one another.

Inferences deal with the examination of a haphazard occurrence, based on the probability theory.

Experimental and *observational* studies: A shared objective for a factual research venture is to examine causality and make a determination on the impact of changes in the estimations of indicators. There are two noteworthy sorts of causal measurable examinations: exploratory investigations and observational examinations.
The contrast between the two kinds lies in how the examination is directed, howeverboth can be powerful. The examination includes taking estimations of the framework under examination, controlling the framework, and afterward taking extra estimations utilizing a similar technique to decide whether the control has adjusted the estimations. In an observational examination, information is accumulated and connections amongst indicators and reaction are researched, (Lodico, et,al. 2010).

1.9 Limitations and Delimitations

- Illiterate workers:

The field workers at the Industrial Parks are mostly illiterate. However, they are skilled in the various tasks that they undertake. The illiteracy makes it difficult for them to complete the questionnaire. The workers will then be interviewed as a form of data gathering to ensure that the researcher gains sufficient and accurate data.

- Sample size too small

There are a limited number of Industrial Parks in the South-Western Township, which thus limits the sample size that will be analysed. This makes it difficult to find significant relationships from the data because statistical tests require a large sample size to ensure a representative distribution of the population and to be considered representative of groups to whom results will be generalized. The sample will be statistically derived by analysing the available population, This will ensure that the data collected is valid and reflects the reality of the industry.

- No prior research in Soweto

The implementation of Eco-industrial parks has not been implemented in Soweto. This is a challenge because there has not been any data recorded for it. The researcher will use Brazilian Russian, Indian and Chinese (BRICS) data as benchmarks, as these are the countries that are closely related to South Africa in terms of economic development.

1.10 Chapter layout of the research

The chapters are structured as follows:
Chapter 2; the *literature* survey comprises four sections:
Section 2.1: consists of definitions and applications of environmental impacts
Section 2.2: involves the discussion of various Eco-industrial parks globally,
Section 2.3: lists the number of successful projects in South Africa that are aimed at being future Eco-industrial parks.
Section 2.4: this section is concerned with the critical analysis of the best-cited research papers.

Chapter 3: *Method:* the method encompasses the Objective Epistemology as a research philosophy, the inductive research approach, the action research strategy used, the Mixed Method research choice, the cross-sectional time-zone and the questionnaire and direct observation used as a research technique and approach.

Chapter 4: *Results*. This chapter will portray the findings of the study based on the Statistical package for Social Scientists (SPSS).

Chapter 5: *Discussion*. This chapter will analyse and make sense of the results in relation to the study objectives. The chapter will also deal with the establishment of categories and subcategories of the study. The results on this characterisation will be discussed in detail.

Chapter 6: *Framework Design*. This chapter deals with the design of the framework. The framework is made up of four main areas, The Organisational, Sustainability, Development and Waste monitoring and Control. The successful application of these principles would lead to a successful development of an Eco-industrial park.

Chapter 7: *Conclusion*. The main objectives and sub-objectives are summarised. This section explains how each the objectives of the study were met, and the limitations and contribution of the study. The conclusion further outlines the recommendations for future studies.

Chapter 8: consists of a list of references

Chapter 9: Appendices: this chapter consists of all the appendices that support the study.

2. LITERATURE REVIEW

2.1 INTRODUCTION

The literature comprises four sections.

- Section 2.2: consists of definitions and applications of environmental impacts, and cleaner production of Eco-industrial parks.
- Section 2.3: involves the discussion of various Eco-industrial parks globally. This section entails the discussion of the largest Eco-industrial parks and their components, stretching from Denmark to the United States of America.
- Section 2.4: lists the number of successful projects in South Africa that are aimed at being future Eco-industrial parks. These parks are in the Limpopo province and the Western Cape.
- Section 2.5: is concerned with the critical analysis of the best cited research papers in developing world. The analysis is made over a 20-year period, from 1997 – 2017.

2.2 LITERATURE REVIEW: THEORIES AND CONCEPTS

2.2.1 Environmental impacts

The environment is characterised as all the physical, compound and natural components outside of people and all their related practices (Smith, et.al 2009). This implies the environment is what is outside people. It is presumed that physical, organic, traditional and social factors impact the wellbeing of the population. Figure 2.1 below demonstrates one approach to viewing the environment, from the most comprehensive to the most limited definition (Smith et.al 2009).

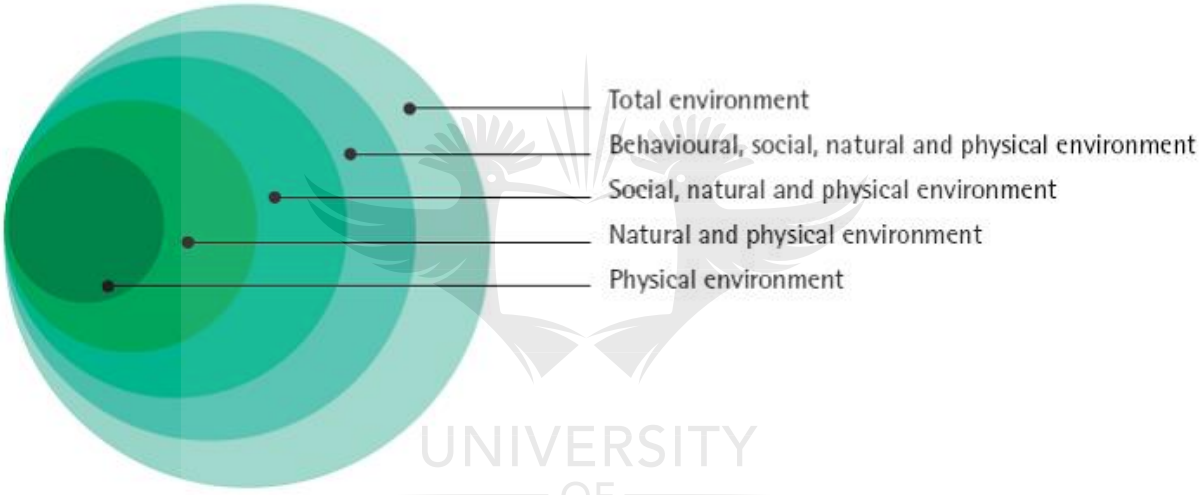

Figure 2.1: Environment defined (Adapted from Smith, Corvalàn and Kjellström, 2009)

The rapid rise of the population and development of resource–utilization, joined with industrialization, urbanization, agricultural increase and asset-concentrated ways of life are adding to overall environmental, social and monetary stress. Environmental degradation continues apace, while global warming changes are causing cataclysmic weather events (e.g. surges, dry spells) including species extinction and the pulverization of common environments (Gattie et.al, 2003). Social and monetary issues, for example, the imbalance in asset dispersion and access to medicinal services are additionally undermining the quality of people's lives. In this specific situation, improvements have to be considered that are comprehensive and limit damaging social, financial and environmental impacts. This thus will maintain the wellbeing of the biological system to which individuals are part., (Smith, Corvalàn and Kjellström, 2009).

Environmental effects can be deemed positive or negative to human wellbeing, land, water and air. Environmental effects are surveyed to guarantee that any negative effects on either human wellbeing, land, water or air are either dispensed with or decreased.

The environmental evaluation method ensures that the environmental consequences of options are taken into consideration prior to when the decisions are made. The basic practice is to guarantee that designs, projects and activities affecting the environment are made subject to an environmental assessment and preceding their endorsement or approval. Consultation with people in general is a key component of ecological evaluation methods. (Singh *et al*. 2007)

2.2.2 Industrial Parks and Cleaner Production

An Industrial Park is defined as "a huge tract of land, sub-separated and produced for the utilization of a few firms all the while recognized by its shareable framework and closeness of firms" (Cote *et al*, 2008). Equivalent words for Industrial Parks include industrial estates, industrial districts, export processing zones, industrial clusters, business parks, science and research parks, and bio-technology parks. The expression "Industrial zones" alludes to a territory of land put aside for industrial offices without a clear reason for encouraging or advancing the arrangement of normal foundation and administrations (UNIDO 1997). An Industrial Estate is a zone that is isolated from urban and densely populated regions and zoned particularly for the area of Industrial facilities. Industrial Estates must help legitimate systems, for example, streets, control, water supply, and other utility administrations to all offices situated inside the estate.

The economic gains of developing an Industrial Park often come at a loss of environmental quality within and around industrial estates. Ecological concerns have frequently not been measured and assimilated into the preparation and construction of IPs (UNEP/SEPA, 2001, UNEP/SEPA, 2002). Important environmental issues include water, wastewater and waste management, in addition to air emissions, odour and noise. In particular, water shortages are becoming increasingly serious, presenting a possible threat to the development of IPs and water security in general. Similarly, with rising manufacturing and consumption there is an upsurge in waste, which needs to be properly handled (UNEP/SEPA, 2002).

The creation of green industries implies the achievement of the industrial supply of a diversified set of environmental goods and services, such as clusters of renewable energy developers or re-cycling and safe disposal of waste streams. The second category, the greening of industries, refers to all industrial activities (UNIDO, 2012). It entails the waste and emission reduction in individual plants, through a high level of coordination of their individual environmental initiatives. Another example is through waste (solid, liquid, gaseous) treatment in collective facilities for reuse by other enterprises.

The reported potential advantages of environmental management at the level of Industrial Parks include (UNEP/SEPA, 2001a):

- IPs are export oriented and therefore the environmental management practices of IP companies become gradually in line with international standards
- Environmental management should rely on measurements to achieve high efficiency
- Environment affects investment
- Eco-industrial parks put more effort in controlling environmental quality than normal areas
- EIPs can serve as special designated areas to test new environmental management practices and advanced instruments.

A positive net economic effect is made by many environmental investments and services because they make manufacturing more efficient, i.e. a decrease in waste, energy inefficiency and loss of materials. They also lower the costs of environmental compliance. Where benefits are properly shared between the park management and its tenant companies, all parties can benefit. The park manager can recover some of the costs made for environmental management services by charging fees to tenant companies. Some environmental services can also be provided by private contractors which can charge a fee which is lower than the costs (Francis, 2001).

Cleaner Production is the consistent use of an incorporated, preventive ecological method of procedures, items and administrations to build general productivity and decrease harm and dangers for people and the earth as indicated in Figure 2.2 below (Bonilla, 2010).

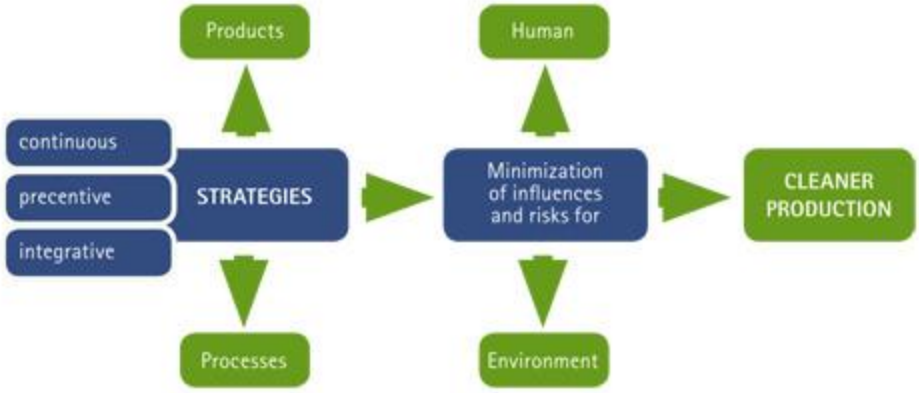

Figure 2.2: Cleaner Production. (Bonilla, 2010)

Cleaner production (CP) is a term of expanding significance since the Johannesburg 2002 World Conference on Sustainable Development. It is characterized by the United Nations (NCPC, 2007) as, the continuous use of an combined preventative system linked to procedures, objects and administrations in order to increase eco-proficiency and reduce hazards to societies and the earth" (NCPC 2007).

Cleaner Production plans to decrease the environmental, health and security effects of products over their whole life cycles, from crude materials extraction, through manufacturing and use, to 'a definitive' disposal of the item. It additionally implies combining environmental worries into outlining and conveying administrations, as shown in Figure 2.2 above.

Cleaner Production includes straightforward methods extending from housekeeping to more innovation driven procedures, for example, new product or process outlines and innovation exchange. It is an all-encompassing way to deal with environmental protection since it addresses the difficulties of sustainable development at several levels. The idea of Cleaner Production has been known to be a compelling method that enables industry to perform above its standard levels (NCPC, 2007).

A National Cleaner Production Procedure for South Africa is being drafted (NCPC, 2007). The system is imagined as helping sustainable development and the change of the personal satisfaction of every single South African. This is being done through an organized way to deal with coordinated contamination and waste administration that uses the financial, administrative and specialized standards and instruments of cleaner production (NCPC, 2007/. This is for the compelling reduction of resource use and minimisation of the effects of pollution and waste on the natural environment and on human wellbeing.

Cleaner production has shown itself to be a viable path towards the idea of practical improvement. In a developing nation, for example, South Africa, the environmental concerns must be adjusted by considerations of economic development and job creation. Cleaner Production commonly brings about a 'win-win' procedure for preserving the environment and lessening the potential dangers to the environment and human well-being, without underplaying the significance of economic improvement. (NCPC 2007). Applying the idea of Cleaner Production at the scale of an Industrial Park may lead the way to eco-industrial networks that trade materials and acknowledge collective sustainable benefits.
In the broadest sense, industrial areas that are either outlined or renovated for this object are called Eco-industrial parks (EIPs).

2.2.3 **Eco-Industrial Parks**

An Eco-industrial park develops when organisations in an Industrial Park liaise together with the surrounding communities with the aim of limiting contamination and waste, recovering ecological quality and efficiently allocating resources. All these efforts lead to economic and environmental gains (Lowe, 1997).

The difference between Industrial Parks and Eco-industrial parks is dependency and collaboration. As indicated in Figure 2.3. below Industrial Parks have businesses that are not part of any network, they do not exchange any raw materials, and have independent waste management techniques.

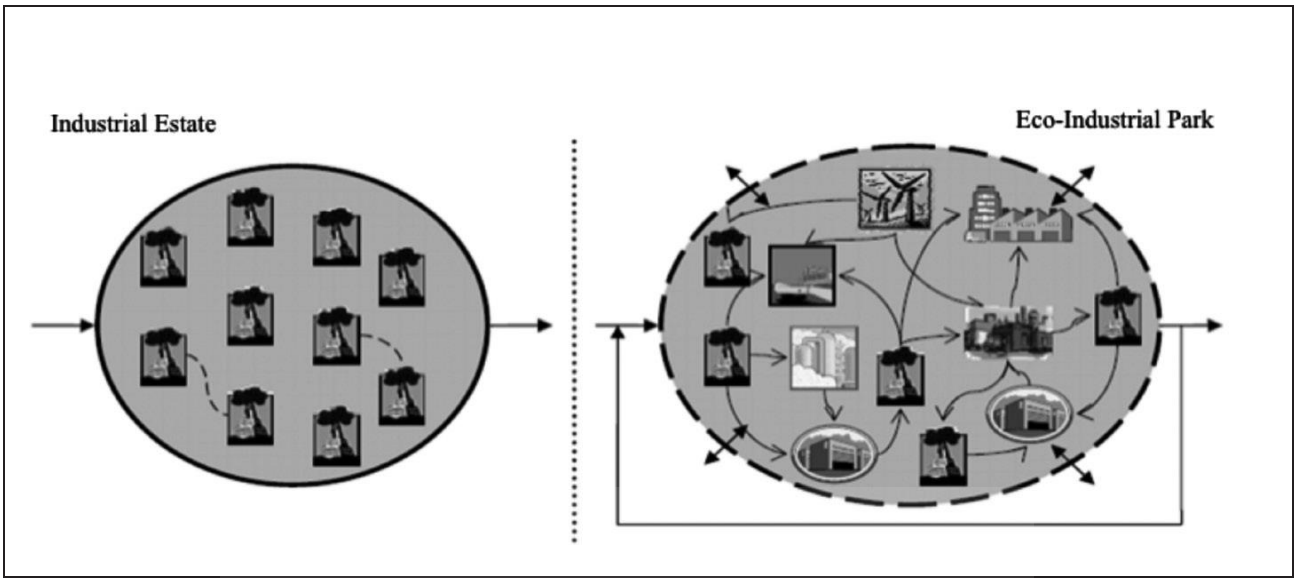

Figure 2.3: Industrial park and Eco-industrial park. (Mouzakitis *et al*., 2003)

The term Eco-industrial park, as is the case with the term industrial ecology has a few definitions, (Cote and Hall , 2005:) proposed that an Eco-industrial Park is an industrial framework which conserves natural and economic properties; optimises manufacturing, improves working efficiency, quality, workers' wellbeing and public image; and gives chances to income generation from utilized wasted materials.

Lowe *et al* (2007) characterized it as a group of manufacturing and service organizations looking for improved natural and monetary execution through coordinated effort in overseeing environmental and assets issues including energy, water and materials. By cooperating, the group of organizations looks for an aggregate benefit that is greater than the benefit of the individual business.

The aim of an Eco-industrial park is to almost eradicate the net generation of waste, effluents and emissions. The term Eco-industrial park (EIP) has become the umbrella term for parks practicing collective environmental initiatives in their design, construction and/or ongoing operation and management (UNIDO, 2014). The stakeholders involved in the establishment of, or conversion into, an EIP are:

- Developers and investors, private or governmental, who are often mainly concerned with economic return from land conversion into industrial park and may be concerned that good environmental practices are costly

- Government decision makers and managers, responsible for setting environment and industrial standards, providing policy and investment incentives and thereby enabling industry creation in Industrial Parks
- Company decision makers, including future and present tenants
- Environmental managers employed by present and future tenants and providing services for tenants and park managers
- Consultants for environmental planning of the EIP
- Involving the public, in particular, communities directly affected by the Industrial Park
- International community, including bilateral and multilateral aid agencies and international financial institutions
- Customers whose pressure and awareness may influence the decision makers and the private sector
- The stakeholders' impact depends on their environmental awareness and scope of their responsibility.

These stakeholders Eco-industrial parks have been assessed in various comparative studies, mostly in developed countries (Massard *et al*, 2014; Van Berkel, 2006). A key lesson is that EIPs simultaneously require innovations in business relations, between companies, and resource flows (Van Berkel in UNIDO, 2012). The benefits for all involved enterprises include reduced net waste generation and/or resource consumption; the adoption of new technologies towards resource conservation; and the creation of new products and the provision of environmental services to urbanized areas. The identification, evaluation and eventual realization of such innovations involve both the assessment of industrial processes and their resource consumption and by-product generation, as well as synergies and networking among enterprises. Third party facilitation is critical for such eco-innovation and can contribute to embedding environmental awareness and action at the level of enterprises and their staff. So far, the following drivers for EIPs in developing and emerging countries have been promoted (Massard et al, 2014; Van Berkel, 2006):

- Environmental and resource conservation benefits
- Operational costs saving, and
- Technology learning and adaptation.

2.2.3.1 *Objectives of Eco-Industrial Parks*

The objectives of an EIP are to advance energy preservation, and the reduction of emissions, by concentrating on the execution of green stream networks. In particular, the aims of an EIP are as follows (Zhang, 2010):

- Establish an incorporated structure that grasps economic advancement, natural quality, and social value
- Stimulate interests in the private segment, subsequently expanding business openings identified with assets reusing and empowering country and urban group improvements
- Pursue the objective of zero emanations and working up a reusing-based feasible society
- Manage waste reduction and reuse advancements to accomplish objectives of combined recuperation and zero waste

To meet the targets of EIPs, according to Zhang (2009) a few methods are recorded below:

1. Policy producers ought to make strategy which advances the reduction of carbon discharges and enhancing energy proficiency.
2. Future designs should develop manufacturing productivity while looking for participation between all manufacturers in a recreation centre.
3. Creation of a practical coordinated green authentication market. Valuing procedures, for example, tax exceptions and carbon credits, ought to be executed.
4. Information about manufacturing procedures, free market activity of materials and energy, resources for assistance, and human preparation ought to be made effortlessly open.

2.2.3.2 *Importance of Eco-Industrial Development*

The environment can benefit greatly from EIP development. The benefits included reducing carbon emissions, reducing the consumption of water and energy, and limiting the releases of wastewater. The types of environmental benefits vary between EIPs in terms of the composition of tenant enterprises by sector, size and level of technology and management. Equally important for the reduction of environmental impacts are the development of relevant indicators, their monitoring and the enforcement of environmental and related policies and standards. Eco-industrial parks have environmental benefits and economic benefits.

The following are the general environmental benefits that were identified from Industrial Parks (Heeres, 2004):

- Decrease in air contamination
- Decrease in soil contamination
- Mitigation of emissions of CO^2 and possibly other greenhouse gases lowering contributions to climate change
- Lessening the consumption of water
- Preservation and protection of biodiversity and nature
- Decrease in compact and harmful waste
- Reuse, recycling and recovery of waste
- Reduction in space needed for waste storage
- Disaster risk reduction

2.2.3.3 *Economic Benefits of Eco-Industrial Development Eco-industrial parks*

The primary financial advantages are direct and indirect creation of employment, savings on costs based on the decreases in waste, the consumption of resource and energy, and enlarged competitiveness (Chertow, 2005). In absolute terms, the scale of economic advantages varies, largely depending on the size of the park with the benefits of a large EIP being greater, as indicated in Table 2.1 below. The indirect benefits are more difficult to determine but are very important for long term economic development.

Table 2.1 Types of reported direct economic benefits. (Chertow, 2005)

Direct employment creation and income generation	Foreign direct investment	Reduced resource costs	Avoidance of regulatory penalties due to waste charges
Export growth and export diversification	Government revenues	More efficient material use	Increase in income per capita
Foreign exchange earnings	Increased competitive-ness of companies	Increased sales through green marketing and image	Meeting customers' requirements
Reduced costs for waste management	Reduced energy costs	Reduced costs of water consumption	Reduced costs for transportation
Benefits for industrial and residential infra-structure	Integration with regional, national and international markets	Mixed land use planning	Improvement of the business/investment climate
Access to investment capital	Access to environmental credit lines	Access to environmental certification	

2.2.3.4 ***Drivers and Barriers***

Many of the drivers and barriers that are being mentioned in the cases are to a high degree specific to the respective case.

A policy review shows a large variety in approaches. Most countries have no special policies for EIPs. Some have no department or ministry dealing with environment or natural resources. But all are aware that they are facing growing issues of environmental pollution on the one hand, and access to natural resources that is needed in order to foster economic development, on the other. The policies can be centralized or decentralized and focus on specific environmental indicators, such as energy efficiency. Environmental development and industrial development can be contradictory or complementary in structure. More coherence is accordingly needed among agencies for environmental and economic development. (See Table 2.2 below.) Inclusive policies also (besides industrial growth) look at human development as well as socially responsible industrial growth (Tutor, 2007).

Table 2.2 Drivers of Eco-Industrial Parks, Tutor (2007).

Driver	**Explanation**
Financial support for eco-oriented technology	Can be in line with government policies, or through banking
Role of government agencies, corporations, institutions and associations	Including changes in institutional structure
Policies	Policy driven EIP, related to renewable energy, incentives, tax exemption, Industrial Symbiosis, green building, Cleaner Production, energy saving
Industrial Symbiosis	Can be policy, network or seed funds
Enhanced infrastructure	Collective management, wastewater, or near urban area with good infrastructure
Resource efficiency and resource saving	Energy, water, materials
Economic benefits	Cost and energy savings,
Support of international organizations	United Nations Industrial Development Organisations, European Union, World Bank Group
Growing awareness	Spread to public, higher awareness in some foreign companies
Technology support and support from universities	International experts, symposia
Positive impacts on local community	Poverty reduction, voluntary participation, infrastructure for resettled villagers

a) Barriers

In developing and emerging countries there are many difficulties arising from lack of experience, lack of awareness and lack of regulations and their enforcement. Identified barriers to developing a successful EIP include the following (Tutor, 2007):

1. Excessive dependence on policies (unreliable when policy changes)
2. Lack of proper organization among companies
3. Lack of management resources
4. Loss of competitiveness
5. Lack of reference and guidelines of what exactly an EIP is
6. Lack of awareness of government, community (e.g. in western part of China)
7. Hazardous waste management and other facilities may not work properly, leading to high environmental pollution

8. Lack of support for Industrial Symbiosis and other environmental measures
9. High proportion of SMEs comply less to environmental standards, which leads to more pollution
10. High price of fuels and natural gas may lead to a switch to coal
11. Multiple sources of water supply hamper the control of water consumption
12. Lack of enforcement of environmental regulations
13. Demand for environmentally superior techniques is weak (e.g. China)
14. Lack of proper indicators
15. Problem of attracting skilled workers
16. Many parks are not fully operational

If the government supports the creation of an EIP financially and institutionally, some problems may arise due to the lack of awareness among government officials, among company managers and park operators. In addition, there may be a lack of indicators and enforcement. In less developed countries, managers of companies are more sensitive to fluctuations in price of energy and materials. There might also be a need to train people from the nearby communities.

2.2.4 **How to develop an Eco-industrial park**

Table 2.3 below provides a comprehensive outline of issues that are essential for the development of an EIP, derived from the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis.

Table 2.3 Developing an EIP through a SWOT analysis. (Patnaik 2015)

Strengths	**Weaknesses**
• Provincial expansion activities and establishments • Closeness of business units • Decent community and monetary structures • Current theoretical base and knowledge on IE • Actual work ethos • Absence of monetary incomes • Cumulative attentiveness	• Hesitant and conservative outlook • Hands-on administration • Absence of dependable records and evidence • Inadequate administration structure and hands-on guidelines and scheduling • Inadequate policymaking influence • Absence of skilled man-power in the businesses who can design and device EIP policies
Opportunities	**Threats**
• Business variety • Like-minded residents • Anchor tenants • Anticipated demand to initiate environmentally friendly initiatives • National and international Co-operation	• Reluctance against emerging concepts like EIP • Constricted attention on temporary financial benefits over eco-efficiency and longstanding benefits • Absence of strategy revolution • Pre-existing synergy base • Absence of communication between strategy creators and experts • Continuous need to introduce new facilities to cater for the requirements IE

2.2.4.1 ***Strengths***

a) Existence of regional improvement agencies and authorities

Businesses need to be satisfied with the socio-financial and ecological developments received as benefits by means of the deliberate EIP form, this will ensure that corporations aggressively take part in the project. (Heeres, Vermeulen, and de Walle 2004; Mirata and Pearce 2006). The authorities as the corporation that are aimed to conserve and guard the environment perform an important part in selling technology, providing recognition to most of the communities regarding ecological troubles, and facilitating clinical studies.

b) Hands-on government

The government, plays an important role in encouraging reasonable eco-industrialisation. Despite the fact that such systems motivate the improvement of EIP undertakings, a solid government request is expected to ensure that there is an authoritative devotion over the long haul (Industrial Master Plan, 2004).

c) Closeness of industrial-units

To build up a fruitful cooperative energy, there must be geographic closeness between the businesses to allow powerful transportation of materials (Chertow 2000; Agarwal and Strachan 2006). Businesses will have to be placed very intentionally, within a place ranging among 25–30 km at a most, with a view to allowing the effective facilitation of transportation among participating industries, with the aim to enable the distribution of raw materials and transferrable resources.

d) Good structure

The region would be required to set out on computerization of its tasks and usage of e-Governance activities through intranet Region-Wide Area Network (RWAN) and Common Service Center (CSC). Availability will be stretched out up to town level so it may be successfully utilised for encouraging EIP methodologies (PIPDIC 2009). The government should give an appealing motivation in a form of sponsorship, lease appropriation, premium endowment and a work appropriation to investors that are commonly absent (PIPDIC 2009). Every one of these variables gives great extension to the selection of EIP methodology in any territory.

e) Present academic-base

Different components of industrial ecology (IE) have been instructed within the setting of the general controls of engineering and the sciences. Scholars and research organisations have been involved in the dispersal of data identified with IE in different inventive ways. Numerous organisations and research focuses have assumed noteworthy jobs in examining different issues that relate to IE (Patnaik 2012).

f) Operative work ethos

A casual culture of work where all administration officials are effectively agreeable would be an additional benefit in creating EIPs (Patnaik, 2012). Effective business management helps provide feedback between participants' needs and problems. Such a methodology has had a significant increase in EIP development.

g) Growing responsiveness

As detailed in the 2012 yearly draft, PIPDIC began an ability improvement mission for charting the breaches in aptitudes, recognizing the gatherings to be prepared and the instructional classes (Draft Annual Plan Report, 2011–12). This carries a one of a kind chance to limit the expertise gaps identified with ongoing advancements in developing countries. EIPs can be logically acquainted in the neighbourhood setting to build up the important labour and aptitudes for this mission.

2.2.4.2 ***Weaknesses***

a) Unenthusiastic and conservative mind-set

The willingness of existing business enterprises to realize the skills of EIP skills is often difficult. Their self-confidence and commitment to work has greatly reduced the efforts of organizations. If private organizations do not do well enough, there is a risk that the web-based idea will end because of low interest (Saikku, 2006).

b) Nonexistence of facts and evidence

There may be a lot of capacity trained to continue the investigation into the industry and the follow-up of activities. As a result, there is not enough information on the pollution in the industry and on how to find and transfer cost information amongst the worst organisation. Information on industrial products and waste pollution is minimal and does not provide a basis for comparative location (Boix et.al 2015). This exposure obstacle can prevent attempts to make informed decisions for projects to find relationships, markets and waste disposal, which can further prevent EIP development (Boix, 2015).

c) Inadequate managing systems and suitable planning

The aim of accelerating the implementation the EIP project requires action plans on the strategic level (Sakr, 2011). Developments are required in areas such as good governance, competencies and visibility of project implementation plans and the plans that involve secondary products resource transfers.

d) Restricted decision-making abilities

Lack of decision making in the areas causes problems of getting the necessary obligations for the programs (Gibbs et al 2007), this is because it is challenging to persuade and gain approval from local and foreign authorities.

e) Absence of economic resources

Local businesses do not wish to put their money at risk. While financial benefits are strong, their care depends on a number of sector-related issues, which prohibits the industry from investing their assets (Gibbs et al 2007).

f) Absence of skilled manpower

The ecology industry and EIP ideas are novel to various industries. Therefore, businesses do not understand yet their part in the facilitation of the benefits between members in the industry (Shi et.al 2012). The application of EIPs requires frameworks, competent labor and advanced technologies.

2.2.4.3 ***Opportunities***

a) Industrial diversity

Diverse group of businesses could have many opportunities to maintain the recycling and retention of information (Koron 2001). The variety offers an excellent opportunity to use the EIP method to produce secondary products and transfer resources with other prospective industries. As the industrial sector is steadily changing in the developed economy, it provides opportunities for EIP development, as the symbiotic passengers will receive administrative care (Koron 2001).

b) Likeminded tenants

In order to advance the Industrial Symbiosis, the affected industry must be varied and be compatible to one another in the production of their materials and their consumption (Patnaik et.al 2006). Many corporate businesses, such as sugar, paper, kettle and granite, offer continuous opportunities to combine products and by-products. Although the decision to prevent any industries that produce pollution must be established, the existing industries may continue to produce heavy and waste-free materials. It is therefore best to adapt to this new method

c) Single or multiple anchor business occupants

EIP can be a success if it depends on the anchor firm, which can be used to bring together the existing industries together by creating links that are built by the by-products around them. The anchor tenant would works as a mediator to endorse the idea of collaboration in terms of services, water and energy from the relevant industries (Hewes et al 2008).

d) Anticipated demand to facilitate environmentally friendly initiatives

Due to increasing the quality and development of cities, there are inevitable conditions: economic, social and environmental (Hewes et al 2008). With many side effects, all environmental health is at stake. As new industrial buildings are growing rapidly, there is an urgent need to make a way to ensure that industrial development is progressing well, by both preventing environmental degradation and promoting environmental industries. This situation opens up opportunities for emergencies like EIP (Hewes et al 2008).

e) Pre-existing collaboration

A limited number of businesses are involved in secondary-product connectivity as there are strict ways of communication between products and services between companies. The current flow of the existing asset can provide a good basis for continuous walking (Sakr et al., 2011). Internal policies and structures will have to be identified in order to implement the desired plans. With such initiatives, it would be less difficult to encourage businesses to adopt concept of EIP.

f) National and international co-operation and policy

The country's governments are currently receiving strong support and cooperation with international organisations concerning technology projects, green economy, sustainable development and environmental management. The industrial policy, however, promotes ecological industries and a stable approach to the sustainable use of indigenous resources, a number of problems related to industry and the environment especially encourage the cluster-orientated approach (MoEF 2012 manual).

2.2.4.4 ***Threats***

a) Working against the traditional mind-set

There is a need for co-operation and the sharing of eco-industrial development information against the philosophy of traditional companies, which often fail to share any information about their industrial and corporate competitors (Patnaik, 2015). Dealing with the traditional sense is very dangerous as it can lead to greater pressure, intense conflicts and depression. This could lead to a low level of businesses participation, which would kill the future EIP successes.

b) Economics over eco-efficiency

In spite of the continued attentiveness on sustainability issues, to cater for the rising demand, the governments and the private sector must continue to think of the traditional approach to economic development.

Excellent markets are based on projects that promote growth rather than promote quality (Guenster, 2011). It is thus risky for local authorities and industries to maintain a lot of interest in the short term, instead of depending on long-eco-friendly companies.

c) Absence of policy novelty

In order to implement an effective EIP, it is necessary to develop an effective and comprehensive EIP policy. The implementation of the EIP strategy requires a significant change in philosophy in companies with a highly competitive culture and issues of trade secrets. Standards and EIP policy recognition are necessary for the use of waste networks. However, conflicts may arise with the existing sustainable programs (Deutz, 2008).).

d) Constant need to launch new facilities

It is always necessary to develop new ideas like the IE concept have been used. This will ensure that the need to sustain pollution governance and management systems grows. The existing SMEs may however, not be able to cope with the ongoing need for long-term change (Veiga,2009).

e) Performance Evaluation Eco-industrial parks

Some research has focused on the industrial symbiosis (IS) on EIP, which is responsible for the exchange of energy and material. These are divided into two categories based on their objectives. One category analysed and assessed the economic, environmental and social benefits of the EIP. The other category includes a life cycle test (LCA) (Mattila et al., 2008), environmental impact assessment (Singh et al., 2007), carbon emissions (Dong et al., 2013), flow analysis (Shien al., 2012), exergy analysis (Valenzuela-Venegas, 2016), renewable energy (Taskhiri et al., 2011) and economic analysis (Ohnishi et al., 2012).

2.3 LITERATURE REVIEW: INTERNATIONAL PERSPECTIVE

2.3.1 Introduction

This section deals with the assessment of Eco-industrial parks that are either at that have been developed internationally. The section focuses on EIPs China, Denmark, Cambodia Colombia, Egypt, El-Salvador, Morocco, Tunisia, Vietnam and India. The development of EIPs internationally provide insight on strategies and frameworks that can be used to develop EIPs in the South African context.

Eco-industrial parks have an international footprint. Several international countries have been identified to have Eco-industrial parks, with Denmark and China leading in technology and innovation. Cambodia, Colombia, Egypt, El-Salvador, Morocco, Tunisia and Vietnam each have two operational EIPs, whereas China and India both have 6 operational EIPs, each consisting of companies between 4 and 10000 (Clift,2015). See Table 2.4. below.

Table 2. 4 Various Industrial Parks internationally were reviewed. Clift (2015)

COUNTRY	CASE	AREA (HA)	NO. OF COMPANIES	NO. OF EMPLOYEES
Cambodia	PPSEZ	360	38	10 000
	SSEZ	528	27	11 000
China	SCIP	2 940	71	17 000
	Guangxi Xianggui Sugar Group	266	4	1 350
	ZNEIP	900	30	2 000
	DDA	104 000	4 000	256 000
	TEDA	34 000	10 000	484 800
	SDA	44 800	1 300	300 000
Colombia	PIEAG	0.4	88	400
	PIESB	Not available	78	Not available
Costa Rica	CIP	45	33	9 000
Egypt	6th of October City	3 600	1 400	140 000
	10th of Ramadan City	5 847	1 300	129 000
El Salvador	El Pedegral	10.4	12	6 500
	Miramar	8 000	11	493
India	IP Nacharam and IP Mallapur	364.2	681	17 000
	APSEZ	2 264	13	2 738
	Mahindra World City	630	62	35 000
	Vapi Industrial Estate	1 140	1 696	247 000
	Naroda Industrial Estate	363	1 100	30 000
	Satchin Industrial Estate	749	600	45 000
Morocco	Sidi Bernoussi Industrial Park, Casablanca	1 000	600	50 000
	Tangier Industrial Park	138	107	25 000
Peru	Industrial Park «EcoPYMES Pantanos de Villa»	13.7	300	3 670
	Industrial Park «EcoPark Callao»	4 600	3 180	25 000
	Industrial Park «EcoPark Pucallapa»	44	80	0
South Africa	Western Cape Industrial Symbiosis Programme	virtual	virtual	virtual

Tunisia	Bizerte Economic Activities Park	81	62	5 470
	Industrial Area of Djebel Oust and Bir M'Cherga	228	105	23 000
Vietnam	Thang Long Industrial Park Corporation	274	78	63 600
	Vietnam Singapore Industrial Park	500	240	96 367

2.3.1.1 *Kalundborg Eco-industrial park*

The Kalundborg town is located in Denmark (see Figure 2.4), which is close to Copenhagen. Approximately 50 000 people reside in this town and thus it is regarded as a small compared to other towns in Demark. It is known as one of the important symbiotic Industrial Parks, defined by Chertow (2010), characterised by the continuous exchange of energy, waste, and water between clusters of firms and the municipality. This park was developed as a strategy that aimed to assist local businesses in the area in terms of environmental and financial sustainability, further creating a network of collaboration amongst the businesses in the area.

Figure 2.4: Location of Kalundborg in Denmark. (Source; Worldatlas)

The Kalundborg Industrial Symbiosis model consists of five businesses other than the Kalundborg District: Asnaes DONG Vitality (control plant), Statoil (processing plant), Gyproc (plasterboard producer), Kara-Novoren (squander the executives organization), and Novo Nordisk (pharmaceutical and biotechnology organization) (Burström, 2001). It further has numerous other little firms outside the modern region of Kalundborg that have harmonious relations with the primary offices.

The region of Kalundborg gets energy from Asnaes (Burström,2001), as an end-result of the water from Lake Tisso. Sothe control plant gives energy to the area-warming framework, which replaces around 3,500 individual warming frameworks. In addition, Asnaes likewise utilizes overproduced gas from Statoil, lessening carbon and ozone harming substances emanations. The fiery remains and the gypsum delivered as waste in the desulphurization procedure of the power plant are utilised by Aalborg Portland to make concrete and by Gyproc for plasterboards. These illustrate a few instances of the advantageous trades among firms in Kalundborg Park. Figure 2.5 underneath demonstrates each relationship built up inside the recreation center.

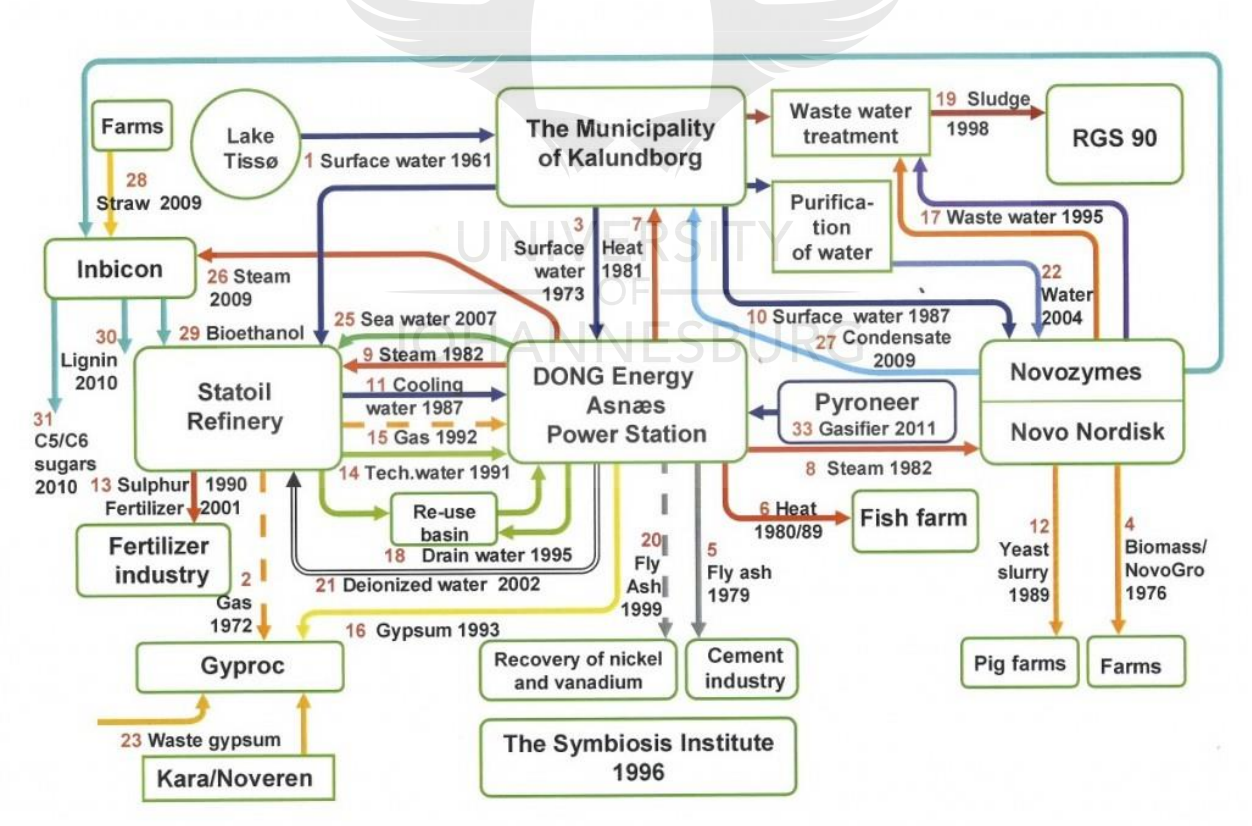

Figure 2.5. Kalundborg symbioses Source: Kalundborg Symbiosis Centre.

a) Structures and facilities at Kalundborg

The park has various eco-infrastructures such as;

- Two sewage treatment plants
- Two cooling systems
- A water purifier and a water container
- A nitrogen disposal plant
- Two waste recycling plants
- Two power plants
- A waste incinerator

The businesses involved in the network have uninterrupted access to these infrastructure and the services provided. These services include site surveillance and monitoring of environmental pollution, assisting with the employment of skilled people and finding potential partners (Starlander,2003).

b) The strengths of Kalundborg park

The qualities of Kalundborg park are as follows; (Mirata, 2005):

- The closeness of numerous large businesses
- The lack of rivalry among businesses
- The monetary motivations for the organisations engaged with contamination decrease
- The lack of legitimate obstructions
- The lack of a pyramidal structure inside the EIP
- The self-governance of the included businesses.

2.3.1.2 *Value Park Eco-industrial park: Germany*

In the year 1998 the Value Park was established by Don Olefinverbund GmbH (a large chemical and chemical company) and that connects Bsl, from Saxony-Anhalt (Saxony-Anhalt) and Saxony. The development of the construction area was created when Bruna was the first manufacturer of rubber materials (Liwarska-Bizukojc, 2009). This park is located in Schkopau town in Germany (see figure 2.6 below) and consists of approximately 3500 occupants.

It consumes approximately 100 hectares of land, about 50 000 m2 in area and 15 large areas. Its main purpose is to provide both local producers and electricity generators an opportunity to build a long-term relationship by improving regional production and interest.

Figure 2.6: Location of the Value Park in Schkopau Germany. (Source; Worldatlas)

Businesses were set up as a network to perform the following (Eilering 2004):

- share infrastructures and services
- provide resources and services
- Purchase and produce products.

This park is categorised by the presence of large chemical chemicals, Dow Olefinverbund GmbH, and 13 other related organizations. This is the industrial community in the park. Dow is the first composer and plays the part of a solid business. Of the 13 companies, six businesses appear to be secondary products. The second management has a symbiotic relationship with the anchor company and produces polyolefins and other plastic products. (Liwarska- Bizukojc et al., 2009). This is illustrated in Figure 2.7 below.

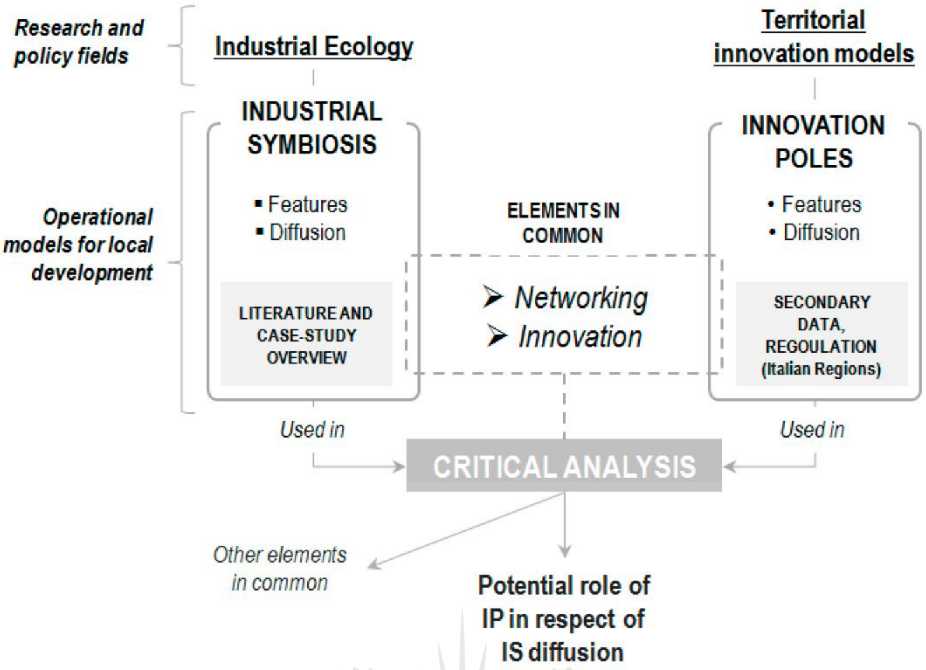

Figure 2.7. Symbiotic network in Value Park. Source: (Liwarska-Bizukojc, 2009)

These organisations are specifically chosen by the anchor-company, Dow, and linked to their most productive work. The most important thing is to be part of the evidence for long-term relationship with other producers in order to improve the quality of evidence (Gibbs, 2005). In addition, the park is linked to the cities of East and Central Europe, two significant markets in the rubber industry.

a) The strengths of Value Park

The advantages of Value Park are as follows, (Fichtner 2005):

- Remote location and close proximity to active Eastern European markets and growing in the rubber industry
- The presence of companies in one sector
- Savings in the cost generated by resource allocation and infrastructure development
- Reduce pollution and waste disposal costs
- The availability of natural infrastructure
- Provision of consultation, environmental services and business management
- International parking image for Dow advertising activities
- The sharing of new information and new approaches to free access to the Department of research and development

2.3.1.3 *Crewe Business Park: England*

The Crewe Business Park is a district of Crewe and Nantwich District (about 114 000 people) northwest of England (see picture 2.8 below) (Olson 2008). It is a acre of 67 hectares, of which only 25% are used for construction, while others remain as a natural park.

The Crewe business park is the first environmental park in the United Kingdom and it is referred to as the first real estate in Britain. It has earned a lot of rewards, including Millennium Mark for Environmental Excellence in 2000; It was one of the business districts in the United Kingdom to earn a prize (Olson, 2008).

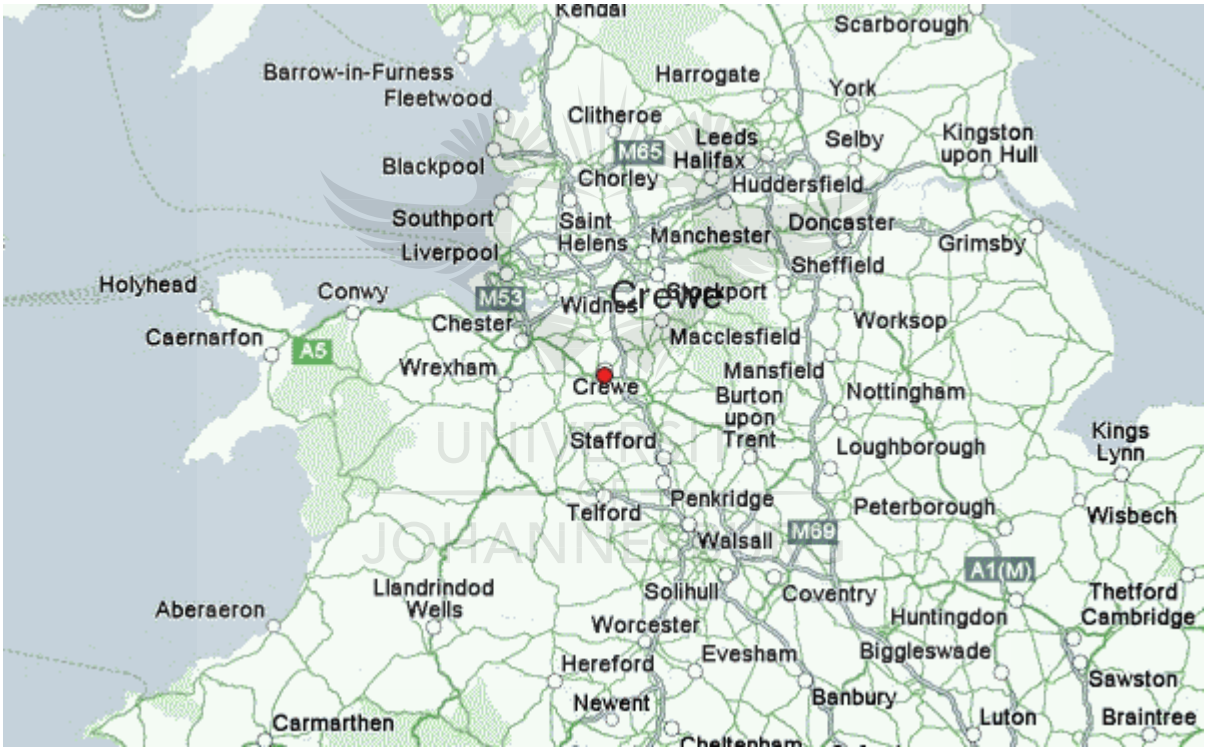

Figure 2.8: Location of Crewe in North West England. (Source; Worldatlas)

This park is linked to major UK cities. Airports in Liverpool, Manchester, and Birmingham are near the park. In addition, the Hams Hall's largest railway station, which operates 170,000 million tons per year, is 90 miles [90 km] from the field (Korhonen, 2005). The key policy evidence is that companies need to help protect natural areas and parks. Its vision is to integrate business with nature conservation (Korhonen, 2005).

b) The advantages of the Crewe Business Park

- The strength of Crewe Business Park are as follows; Lambert, 2002):
- Respecting the environment
- Reduce pollution
- Maintain the costs and benefits of organizations involved in the hire of offices and / or staff housing.
- Organisations receive a reasonable reduction on rent.

2.3.1.4 ***Environment Park in Turin: Italy***

The park was founded in 1996 as part of Piedmont, the province of Turin and the European Union (see figure 2.9 below). It is unique among science and technology parks in Europe for its new innovative skills begin. It has 30,000 m2 of activity among laboratories, offices and production centers (Montastruc, 2013).

Figure 2.9: Location of Turin in European Union. (Worldatlas)

Environment Park uses practical solutions to increase their share in the market. It provides businesses and communities with energy saving solutions, waste disposal, clean energy, novel products, and economic resources, so that they can completely change their ways of doing business. The main objective of the park is to promote environmental sustainability by promoting the association between the private businesses and the public authorities, while promoting eco-efficiency (margins, 2011).

The Park is well integrated into the major cities of Italy and Europe through airplanes, trains and roads. It is about 11 kilometers away from Turin-Caselle airport and approximately 140 km from the Malpensa airport. The Turin train station Porta Nuova is 4.2 km from the park. In addition, Turin is linked to Milan, Genoa, Zurich and Lyon, and other Central-European cities by road (Banks, 2011).

a) The strengths of Environment Park

The key strong points of the Environment Park are as follows (Montastruc, 2013):

- It is the primary park to be totally self-sufficient in terms of energy and using renewable sources
- It has the both the public and private businesses that work aggressively together
- There is a 25% energy consumption reduction, when it is compared to 2005, even though the area has developed by approximately 15%
- There is sharing of information and technologies

2.3.1.5 *Hartberg Eco-park in Austria*

Hartberg Eco-Park in Syria (Austria) near Hartberg, (see picture 2.10 below). This is a small town with 6 600 people. This area is well situated near Europe's most important markets, close to the hardy markets in Croatia, Slovenia and Hungary. The Affected companies in Eco-industry contribute to the production and marketing of environmentally friendly products and services (Jung, 2013).

Figure 2.10: Location of Hartberg Eco-Park in Austria. (Source; Worldatlas)

This park is closely linked to Austria's major cities and the largest airports in Vienna. There are presently 30 small businesses at the Hartberg Eco-park. This organisation created 200 new jobs over the years (Jung, 2013).

Hartberg Ecopark is part of the Syrian environmental project that depends on the use of natural resources, not only in the industrial industries, but also throughout the region. The project value has been the establishment of a regional network of businesses and a research network. These entities work together to improve the environment by repairing industrial waste systems and initiatives.

a) The strengths of Hartberg Ecopark

Businesses are drawn to Hartberg Eco-park as they want to be part of a powerful network and work closely with research institutions and other businesses on issues related to the environment (Jung, 2013). Maintaining low costs and the experience of new green technology are other significant motivators. Other internal investigations measure the annual average reduction in water usage by 10% and the use of energy by 30%.

2.3.1.6 *Devens Eco-industrial park in the United States*

The Devens Eco-industrial park is globally measured as the most progressive Eco-Industrial park in the United States, see Figure 2.11 below.

This park is situated in Devens, Massachusetts. It has a total of 1780 ha, and is separated from the residential and public areas. The area was the US Army military home. After the institutional closure, it has been taken over by the social welfare and development, and renewal authorities. At present, the Devens Enterprise Committee manages park, its mandate has been to empower local areas in terms of environmental issues (Behera 2012).

Figure 2.11: Location of Devens Eco-industrial park in the USA. (Source; Worldatlas)

The park is divided into three parts, each with key performance requirements: the environmental development, logistics and travel, and the maintenance of business activities and production. Each business group includes new design and technology and community structures as part of the additional value given to the park to increase the quality of life of employees (Behera, 2012). The park is integrated in terms of structures and working relationships.

The establishment of Eco-industry at Devens had two main objectives: the conversion of current industrial initiatives in order to incorporate environmental systems and analyze current industry operations, the aim being to create new opportunities in the area. There are 28 organisations participating in this park, these include small and medium businesses, non-profit organisations, research institutions and community organisations (Behera, 2012).

a) The strengths of Devens Eco-industrial park

The key strong-points of the Devens Eco-industrial park are as follows (Gibbs 2005):

- There are many types of community organisations, with more than 4 500 opportunities over the years
- A significant reduction in pollution and costs generated by eco-friendly systems and operations • Technology and information sharing amongst members
- A willingness to compare the growing demand through the development of 106 housing units and 4.2 square feet for emerging businesses.

2.3.2 **Conclusion**

Based on the number of EIPs that exist globally, it is safe to say that there is an appetite for developing EIPs, with the aim of economic, social and environmental benefits. These EIPs could be modified in a framework to suit the South African industrial perspective to be globally competitive in economics and environmental sustainability. It is nevertheless necessary that a framework for Eco-industrial parks in South Africa needs to be developed before it is implemented. This will ensure that South Africa is on par in terms of Eco-industrial parks principles with the rest of the world.

2.4 LITERATURE REVIEW: SOUTH AFRICAN PERSPECTIVE

2.4.1 Introduction

This section focuses on efforts to develop Eco-industrial parks within the South African region. The provinces identified include Limpopo and the Western Cape.

2.4.2 Limpopo Eco Industrial Park

The Limpopo Eco-industrial park (LEIP) is in the North of South Africa. (Ssee Figure 2.12 below). The LEIP project exemplifies sustainable eco-industrial development and demonstrates that industrial economy and environmental health can successfully coexist.

The LEIP may be the first strong waste Eco-Business Park in the world. The main commercial components of this innovation could be a coke plant and a gas to liquid plant. Using the waste generated from these florae, in addition to the entire Musina special financial sector, a Plasma Waste Gasification Plant and a Brick Making factory will form a closed loop, resulting in the introduction of a chain of industries that gain from each other (Lombaard, 2015).

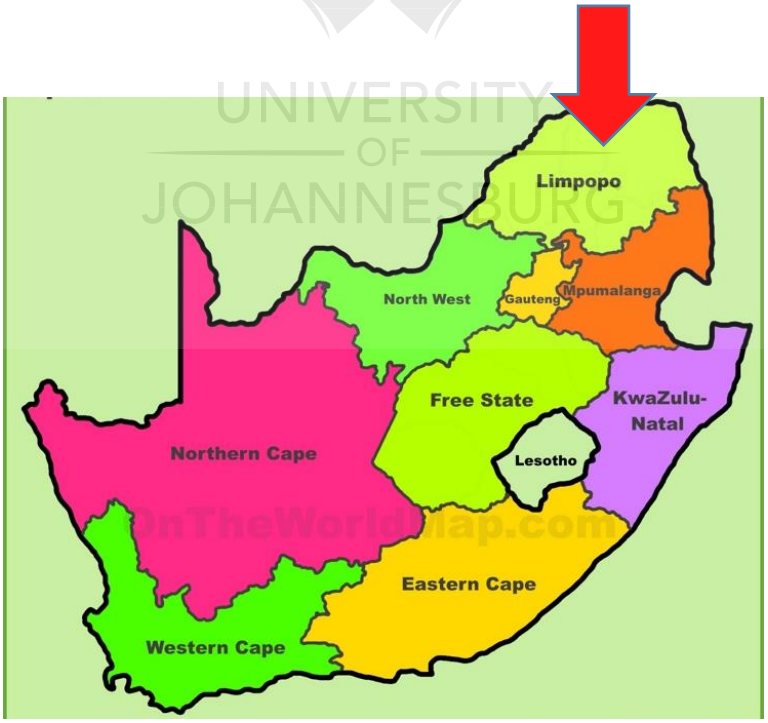

Figure 2.12. Location of Limpopo in South Africa, (Source: Worldatlas).

2.4.2.1 *Facilities of the Limpopo Eco-industrial park*

Key service facilities provided for tenants of the LEIP, as indicated in Figure 2.13 below, Greenberg (2014) include:

1. *Solid-waste Management*: Municipal type solid-waste generated within the LEIP will be collected at a nominal fee and sent to the Coal Gasifier in the CTL plant as biomass feedstock and blended with coal, to produce a high value syngas. Hazardous waste such as dehydrated chemical sludge/cake waste as well as any other solid hazardous and radioactive waste will be removed to the Plasma Waste Gasification Plant (PWGP) for vaporisation at extremely high temperatures, with virtually zero emissions to be treated. Even Low and Intermediate Level Radioactive Nuclear Waste generated by national laboratories, industrial research facilities, educational and medical institutions, electrical power utilities, medical diagnostics facilities and various manufacturing processes can also be vaporised in the PWGP. The LEIP solid-waste management system will render the LEIP one of the world's first zero solid-waste Eco-industrial parks. The vitrified slag that is a product of the gasification process will be used in construction and concrete materials, thereby converting solid-waste material into valuable resources
2. *Bulk Water Supply and Wastewater Treatment*: The LEIP will abstract 20 million m^3 per annum bulk water supply from the Limpopo River, to be stored in two man-made earth dams, from where the water is distributed to all tenants located within and neighbouring the LEIP. The tenants' wastewater will be collected and sent back to the LEIP treatment facilities in a closed loop system. The Wastewater Treatment Plant (WWTP) will be designed to enhance the eco-industrial aspect of the LEIP, using wetlands and filtration ponds distributed strategically along existing riverbeds and water courses. Solids that are filtered and dehydrated from wastewater will be dried and sent as waste to the PWGP to be gasified with other hazardous materials
3. *Power Generation and Distribution*: The LEIP will install 1 MW base load Fuel Cells at start of construction in 2017. An additional 50 MW power to be used specifically for start-up only of heavy industrial plants will be provided from a boiler, as the LEIP customer base expands and power requirements in the LEIP increases. Furthermore, a 200 MW power plant will be built by the LEIP utilising Naphtha, which is a product of the CTL plant, as primary fuel. Once the major heavy industrial plants come online, the LEIP will also purchase approximately 30 MW electricity from the CTL plant, to sell and redistribute to its tenants as well as to the Musina Municipality and other neighbouring users, thereby rendering the entire LEIP energy positive.

4. The LEIP may therefore also export power to the Musina Municipality and nearby industries, if required.
5. *Carbon Capture and Utilisation*: CO_2 will be captured and piped from the gasification island and from the CTL project to the Nitrogen Complex plant as feedstock. Depending on the availability and price of carbon credits, coupled with the South African government's plans to implement a carbon tax, the LEIP may decide in future to build a methanol plant that will convert the CO_2 into methanol, and the methanol would be used to produce Formalin for the market and for the production of formalin-urea resin. Thus, the carbon footprint of the LEIP would be further reduced and an atmospheric pollutant and contributor to climate change will be converted into a valuable resource.

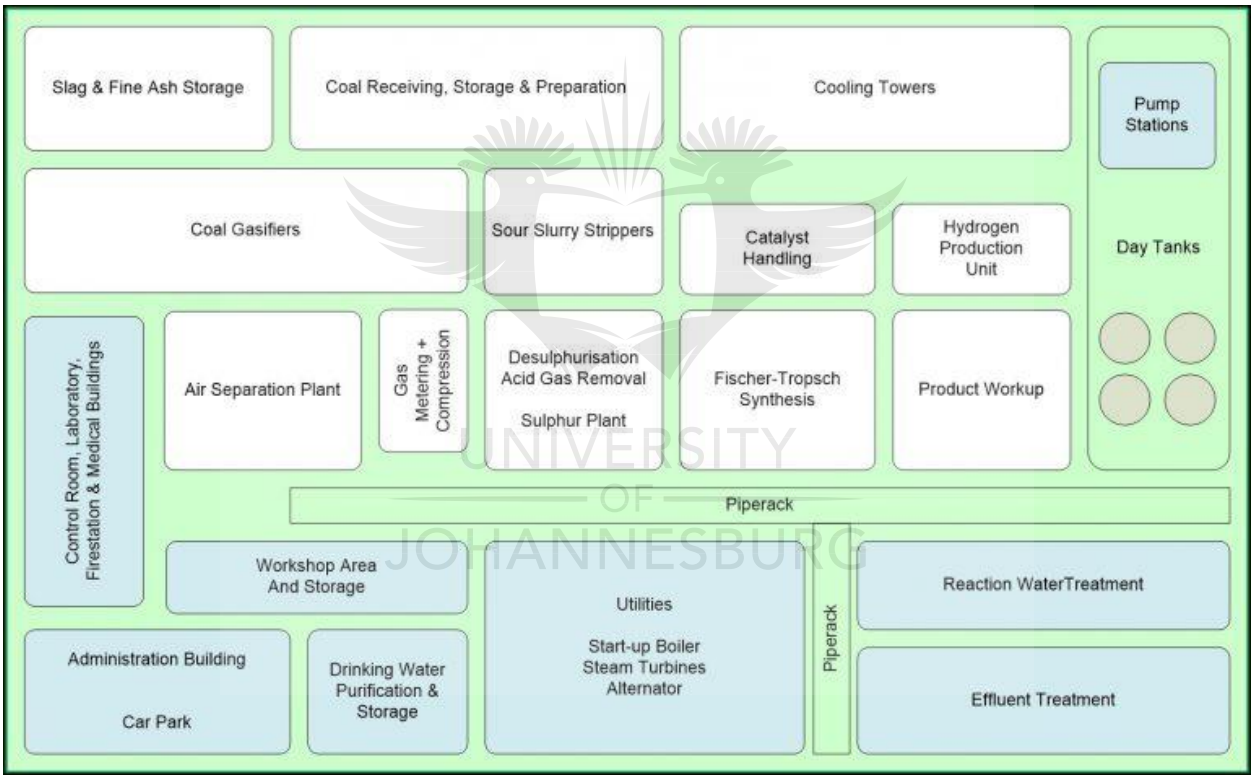

Figure 2.13: Limpopo Eco-industrial park. (Greenberg, 2014).

2.4.2.2 *Components of the Limpopo EIP*

Other key components of the LEIP include, Holzer (2016):

1. A Business Incubation Centre to facilitate both the ideas and the opportunities for new businesses to start-up and operate within the park. The incubation centre will provide support to entrepreneurs, as well as office space and facilities within the LEIP.

2. An independently run Eco-Tourism Nature Park, the extent of which can only be determined during the 2-year construction phase, when the residual impacts will be quantified using a carbon balance accounting tool. The nature park will incorporate approximately 80 chalets, most of which will be sold to the business owners within the LEIP. The approximately 4 500 hectares' nature park area serves to offset any unavoidable environmental impacts associated with the LEIP
3. A comprehensive Skills Development Programme for local inhabitants in and around the Musina area. The programme will focus on developing artisans as well as other skilled and semi-skilled workers for businesses in the LEIP. In addition, the LEIP will provide 3D computer-based simulation facilities for training of factory operators, maintenance staff and plant managers
4. A Research and Development Industrial Ecology Faculty will be provided for postgraduate students, where engineering and natural science graduates will be required to work together on their research. The faculty will spearhead innovation and challenge students to devise theories and develop practical solutions for the industrial-environmental challenges facing humanity today and in future
5. LEIP will develop the Musina Eco-Housing Estate for managers and workers consisting of at least 3,500 units, as well as the Singelele Eco-Housing Equestrian Estate for executives and workers, consisting of at least 800 units. Many of the Musina Eco-Housing Estate units will initially be built for the temporary accommodation of construction workers. The LEIP will supply the housing facility with power; water, communal infrastructure maintenance and waste management services
6. Green Star: The Green Building Council of South Africa Green Star Rating Tools will be applied to administration and industrial buildings, thereby ensuring energy efficiency and other forms of sustainability within the buildings
7. Incorporation and preservation of sensitive environmental aspects, thereby integrating the physical environment with an industrial development.

2.4.3 **Ethekwini Eco-industrial park**

The eThekwini Eco-industrial park in Cape Town (EEIP) (see Figure 2.14 below), is planned as a new commercial and industrial zone within Cornubia. The EEIP is projected to commence its operations in the 2030 as part of the Cape Town strategy towards a green economy.

The EEIP plans to use existing methodologies applied in numerous projects globally such as India, China, Europe and the USA (Aylett, 2011). The application of international best practice will be considered and include a second core component of creating an enabling environment for the green economy sector.

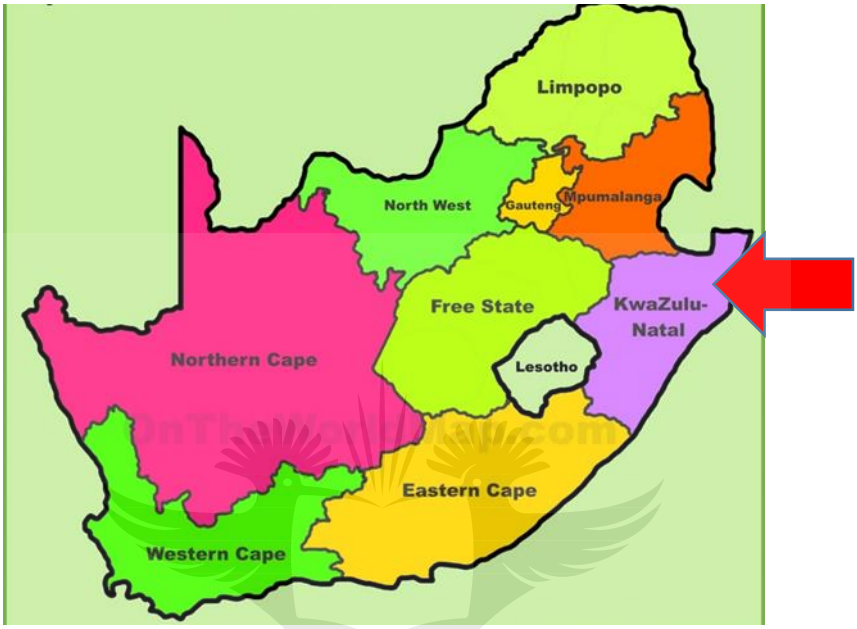

Figure 2.14: Location of Durban, Ethekwini (Source: Worldatlas)

2.4.3.1 *Objectives and Operations of the EThekwini Eco-industrial park*

The objectives of the EEIP is to develop a climate neutral Eco-industrial park within the eThekwini Municipality that promotes cleaner production, pollution prevention, energy efficiency, renewable energy and inter-company partnering. It further aims to develop an Eco-industrial park that actively promotes the green technologies and services sector to supply directly into the broader SADC region (Hickmann, 2017).

2.4.4 The Sasol Chemcity Eco-Industrial Park

The Sasol Eco-industrial park is situated in the industrial hub of the Free State. The site aims to provide a reliable supply of utilities, support services and infrastructure, to ensure an environment that is conducive to successful production, logistics and marketing (Greenberg, 2014), The Eco-Park plans to stimulate the local economy through sustainable job creation opportunities and attracting investment into the area.

The multi-million-rand site is exhaustive to ensure the occupants receive the benefits of a conventional industrial park with an additional benefit of being environmentally friendly.
One of the primary attributes, which sets the park apart, is its ability to minimise its carbon footprint with a long-term strategy to implement carbon reduction projects. Occupants will be provided with a 10-year rates and tax holiday until 31 December 2018, which is in place for all occupants, as indicated in Figure 2.15 below. (Greenberg, 2014).

Figure 2.15: Sasol Eco-industrial park, Greenberg (2014)

Four of these structures will concentrate on assembling exercises, while the fifth will house learning excercises, office-based exercises. The office will possess 4 000 m2 and is being developed utilizing different substitute structure innovations hatched by Sasol ChemCity. What's more, ChemCity broods new companies and since 2005, has built more than 700 SMMEs which has made more than 12 500 direct occupations.

2.4.5 The Western Cape Industrial Symbiosis Programme

The Western Cape Modern Advantageous interaction Program (WISP) depends on the encouraged Mechanical Beneficial interaction programs created by Global Cooperative energies Constrained. It is one of a few Green Economy activities of the Western Cape Government (WCG), supported by the Division of Financial Advancement and The travel industry and began in May 2013. The WCG has made realized its expectation to turn into the Green monetary center of South Africa and Africa, and endorsed a Western Cape Green Economy Vital Structure in 2013, (South African Department of Economic Development 2011).

WISP was initiated in order to address challenges around the continued viability of businesses, as the cost of energy and other inputs rises, impeding economic growth and job creation. Furthermore, WISP is tasked to address landfill diversion as well as the need to reduce the carbon intensity of production processes and improve resource efficiency within production processes. WISP partnered with several government organisations and provincial departments in order to guide the programme and leverage existing networks to recruit members to the Industrial Symbiosis network.

WISP was started to address difficulties around with feasibility of organizations, as the expense of energy and different inputs rises, hindering financial development and occupation creation. WISP is entrusted to address landfill preoccupation and improve asset proficiency within production operations. WISP cooperated with government associations with the aim to direct the program and influence existing systems to select individuals to be members of the Industrial Symbiotic network, Western Cape Government Department of Environmental Affairs and Development Planning, 2014).

2.4.6 Conclusion

The limited number of projects in South Africa indicate a gap in the development of Eco-industrial parks the country. There has been no report of an Eco-industrial park development in Soweto, which indicates that much development is possible for the area. It can thus be concluded that the development of an Eco-industrial park framework for Soweto is necessary for improving the Industrial Parks in the area.

2.5 LITERATURE REVIEW: CRITICAL ANALYSIS

2.5.1 Introduction

This section focuses on the critical assessments of the literature, with the aim of identifying gaps that may exist. The assessment was done over a 20 year period, starting from 1997 to 2017. An overall of total of 93 research papers were analysed under the topic of developing projects Eco-industrial parks. This section explores the number of publications between 1997 and 2017, the sources of these publication, the publication by countries and the type of publications in the respective years. This section further identifies the gaps that exist the area of development Eco-industrial parks, globally and nationally.

The *Journal of Cleaner Production* has been the leading journal in the publication of articles related to this study Eco-industrial parks(see Figure 2.16 below). The reason for this has been that the concept of Cleaner Production evolved from Industrial Symbiosis to Cleaner Production in 2011 (Sakr 2011). This has since been the area in which Eco-industrial parks concepts, theories and innovations have been founded on.

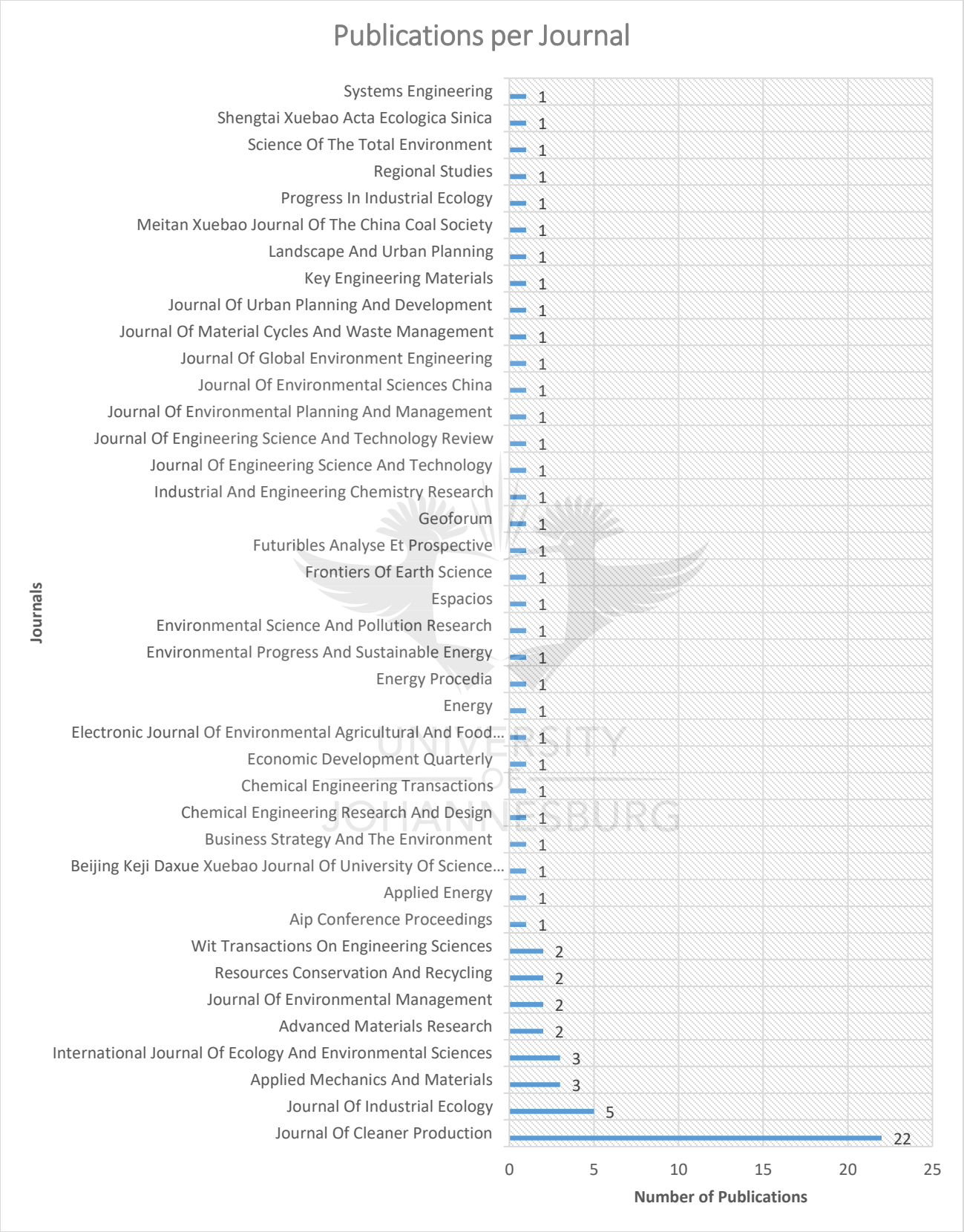

Figure 2.16: Number of publications per journal

The *Journal of Industrial Ecology* also houses publications relating to Eco-industrial parks, however also limited, of the total number of most cited papers over the period of 20 years, five of the articles were published in the *Journal of Industrial Ecology*, whereas 22 where published in the *Journal for Cleaner Production*. Articles related to cleaner production can also be found in the *Journal for Mechanics and Materials*, and *The International Journal for Ecology A and Environmental Sciences*. (See Figure 2.16.above)

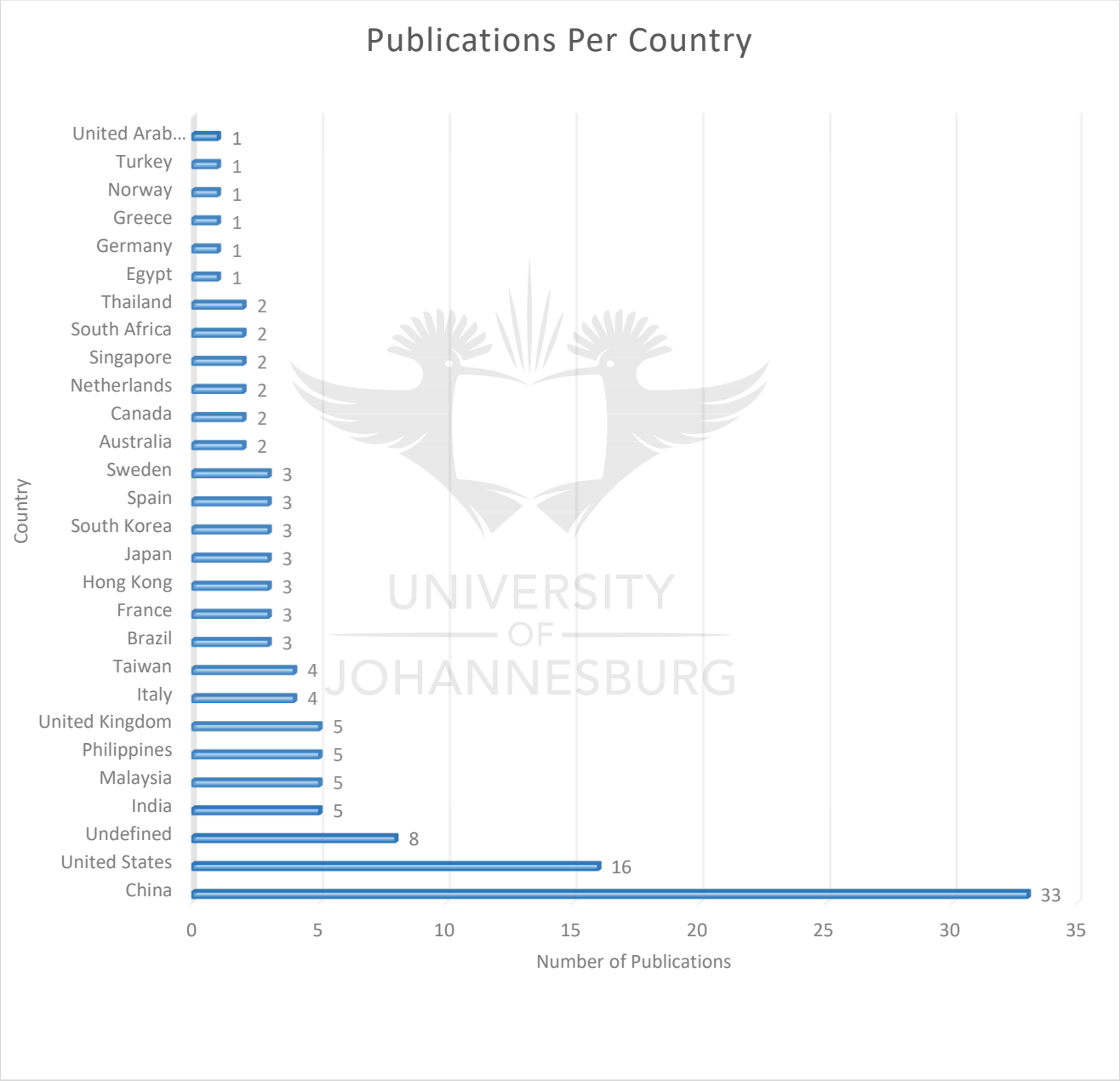

Figure 2.17: Number of publications per country

China has been the country with the highest number of publications in the area of developing Eco-industrial parks globally with a total of 33 publications between 1997 and 2017. This is further indicated in Figure 2.17 and it is followed by the United States of America with 16 publications in the past 20 years.

India, Malaysia, Philippines and the United Kingdom have had a steady growth in the number of publications compared to the rest of the world. They performed better compared to Greece, United Arab Emirates, Turkey, Norway, Germany and Egypt, which were the countries publishing least about Industrial Parks with a single publication each in a 20-year period. South Africa, Thailand, Singapore, Netherlands, Canada and Australia also fall amongst the countries to publish minimally on Eco-industrial parks. This is also a reflection of the slow development and innovation regarding Eco-industrial parks in these countries.

2.5.2 **Critical Analysis**

An assessment of the best cited paper per year over a 20 year period from 1997 - 2017 was conducted. (See Table 2.5 below). The assessment was done based on the main objectives of each paper, the specific focus area within each study, the number of citations each paper has to the date of compiling this study, the sector in which the study was applied in terms of Service or Manufacturing. The assessment further included the various locations in which these studies were carried out, as well as the type of sector that these studies took place, based on whether they were in the formal or informal sectors.

Table 2.5 Critical Assessment of Literature

Author & Year	Main Objectives	Focus	Cita-tion	Application Sector		Location				Type of sector	
				Manufac-turing	Ser-vice	China	USA (US) / Europe (EU)	Africa (A) / South Africa (SA)	Asia	For-mal	Infor-mal
Yik Teeng leong, *et al*. 2017	Determine the optimal resource design.	Integrated Analytic Hierarchy Process	6	X					X	X	
Ming Pan, *et al*. 2016	Develop an optimization process for a complex EIP system.	Multi-level modelling and optimization	17	X					X	X	
Fei Yu, *et al*. 2015	Research the evolution of Industrial Symbiosis and Eco-industrial park construction.	Industrial Symbiosis	34	X		X				X	
Liu W, *et al*. 2014	Establishing a comprehensive greenhouse gas emissions inventory for Industrial Parks.	Green-house gases	20	X		X				X	

Zhang Y, *et al*. 2013	Analysing the density and nodal degree, determined the relative power and status of the nodes in these networks.	Social Network Analysis	9	X		X				X	
Shishir Kumar Behera, *et al*. 2012	Demonstrate the viability of designed symbiosis network using policy instruments.	Designed Industrial Symbiosis	82	X					X	X	
Sakr D, *et al*. 2011	Examine means to improve the uptake of cleaner production and Industrial Symbiosis in industrial areas.	Improved economic and environment--al sustainability	54	X				X (A)		X	
Han Shi, *et al*. 2010	Assessing environmental benefits of key symbiotic exchanges in Economic-Technological Development Area (TEDA).	Industrial Symbiosis	148	X		X				X	
Lovelady, *et*	Developing an	Optimization	82	X			X			X	

al. 2009	optimization-based approach to the design and integration of Eco-industrial parks.	and process integration					(US)				
Hewes, *et al*. 2008	Establish humanistic connections to advance the Industrial Ecology project.	Social relationships in Eco-Industrial Parks.	65	X			X (US)			X	
Gibbs, *et al*. 2007	Investigate whether EIPs offer possibilities to implement sustainable development policies.	Sustainable development policies	183	X			X (EU)			X	
Haskins 2006	Reviews the relevant literature and considers the relative usefulness of industrial ecology, systems science, and industrial net-work theory for understanding Eco -industrial parks	Multidisci-plinary approach and knowledge-sharing techniques	17	X			X (EU)			X	

Gibbs, *et al*. 2005	Develop a sympathetic critique of industrial ecology by focusing on the key problems and dilemmas that arise in the course of developing an EIP.	Sustainable development in EIP, economic, social and environment-al analysis.	125	X	X		X (US)			X	
Anthony, Chiu, *et al*. 2004	Develop and Eco-Industrial Development (EID) strategy for developing countries.	Strengths Weaknesses Opportunities and Threats (SWOT) analysis, strategic planning and sustainable development	88	X	X	X				X	
Fons *et al*. 2003	Application of fuzzy cognitive mapping analysis to study the impacts of developing an Eco-industrial park (EIP).	Waste reduction approach using fuzzy cognitive map	2	X			X (US)			X	X
Wilderer *et al*. 2002	Analysing the overall benefit for	Endogenous growth	1						X	X	

	development of industrial estates, and its negative effects on the environment.	theory and Human Capital Development									
Krrishnamohan *et al*. 2001	Introduces the idea of EIP and describes the advantages and disadvantages of EIPs using Kalundborg symbiosis as a case study. The paper also briefly describes other EIP initiatives in developed countries such as Austria, Canada, and USA and in developing coun -tries such as India, the Philippines, and Thailand.	Kalundborg industrial symbiosis	2	X			X (US)			X	
2000		No Publications									
1999		No Publications									
Potts Carr 1998	Investigates the concepts	Eco-industrial	40	X			X (US)			X	

	of industrial eco-logy and Eco-industrial parks and applies those concepts to the redesign of an existing industrial park in Choctaw.	park, Industrial Ecology and Sustainability									
Lowe 1997.	Reviews a range of methods for supporting the creation of exchange networks in new Eco-industrial parks.	Eco-industrial parks, Industrial Ecosystems and industrial Ecology	159	X			X (US)			X	X

Lowe (1997) suggested a By-Product Exchange System method when developing a new Eco-industrial park. This method involves each entity of a network within an industrial park selling its by-products to another entity, also within the network, which serves as an input, to reduce the amount of waste that is generated within the entire Industrial Park. This study provided a step-by-step process of developing an Eco-industrial park in Europe, North America, Asia and Latin America; however, it did not indicate any strategies for developing Eco-industrial parks in Africa or South Africa specifically. Lowe (1997) suggested that the By-Product Exchange Framework requires an analysis of the energy and materials produced and used by the industries in the Industrial Park. These analyses would be possible in formally structured parks where data would be available for each entity of the park. They would however be challenging for an informal Industrial Park as data is likely to be unavailable.

Potts (1998) used the Industrial Ecology Framework to plan and design an Eco-industrial park. The Industrial Ecology framework is concerned with the principle of Reduce, Reuse and Recycle with the intention of preserving raw materials and nurturing the environment. In this approach, an inventory analysis of energy and raw materials is conducted in the tyre, hydroponics, screen printer, plastic, toner and cartridge manufacturing organisations. The study failed to apply or propose methods for developing an Eco-industrial park in a service environment. The study, however, did not indicate if the principle of Reuse, Reduce and Recycle can be applied in a service environment. The Industrial Ecology framework used in the study also indicated a gap as it requires the measurement of inventory to assess the amount of waste produced. It does, however, provide a means to analyse waste without considering an inventory analysis as this would be applicable in the service sector.

There were no studies that were cited during 1999 and 2000. Krishnamohan (2001) analysed the different stages of development of Eco-industrial park in various countries. The study emphasized the economic relevance and significance of Eco-industrial parks. It analysed Austria, Canada, Unite States of America, India, Philippines and Thailand. It indicated that in Eco-industrial parks there is a collaboration of Service and Manufacturing Organisations. The study failed to analyse the development or potential development of Eco-industrial parks in the Africa. The study used the Kalundborg Industrial Symbiosis is a case-study for benchmarking.

Wilderer (2002) assessed the Eco-industrial parks in Asian countries using the Endogenous Growth Theory. This theory stresses that for an Eco-industrial park to significantly contribute to the economy, there needs to be an investment in human capital, knowledge and innovation.

This study focused on structured and formal Industrial Parks, with emphasis on the formal processes within the Park. The study failed to apply the endogenous theory in an informal Industrial Park. It furthermore only dealt with Asian countries, therefore not considering African countries such as South Africa.

Fons (2003) used Fuzzy Cognitive Maps to analyse the Environmental Impacts of Eco-Industrial Parks. Fuzzy Cognitive Maps to provide a way to model inter-relationships or causalities. The study found that pollution increased as a result of collaboration of the businesses within the Industrial Parks. There was a decrease in waste production as a result of selling of by-products between the entities in the Industrial Park. The study focused on the manufacturing industries and did not consider service industries. The study's focus was limited to the Lloydminster area, as it was considered to reflect a typical industrial area in the context of increasing development and population growth. The study, however, did not consider developing countries outside the Canadian region.

Chiu (2004) aimed to consider ways to develop the Eco-Industrial Development for developing countries. The study used the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis to analyse preconditions for the development of a successful Eco-industrial parks, focusing specifically on Asian countries. The study found that Asian Developing Countries need to adopt Industrial Ecology as a strategic approach for social, ecological and economic development. The use of SWOT analyises helps to identify gaps in the development of projects, and also identifies the benefits and advantages of these developments. SWOT analysis, however is specific to an area of application, and thus the results would be different for every country. This means that the results obtained from the Asian countries cannot be applied literally other countries.

Gibbs (2005) assessed ten Eco-industrial parks in the United States of America (USA). In the assessment, the objective was to determine the economic, social, and environmental benefits of developing Eco-industrial parks in the USA. The study found that while the benefits in question are absent in the early stages of developing an EIP, they are prevalent in the long term. The study further found that the development of policies to govern economic, environmental and social factors play a critical role in ensuring that EIPs operate to benefit the communities that they serve. The development of policy in EIP, would be applicable to formal EIPs, and would be challenging to apply to an informal EIP due to the absence of a business structure. The study failed to assess the development stages of countries beyond the USA, thus limiting its findings.

Haskins (2006) reviews the relevant literature and considers the relative usefulness of Industrial Ecology, systems science, and industrial network theory for understanding Eco-industrial parks. This study also analysed the Kalundborg Industrial Symbiosis and found that the successful development of an EIP requires the following:

1) The companies must fit each other: An Industrial Symbiosis requires that one company's residual products must be appropriate as another company's raw material.
2) The companies must be located near each other: The physical distance between the individual companies is directly related to the cost of transport of residual products.
3) There must be openness between the companies: The partners report that the basis of the symbiotic cooperation within Kalundborg is openness, communication, and mutual trust.

This study focused on the application of these factors within the borders of Canada. This means that these factors have not been applied or tested in Africa. The principles, though, do seem to be valid in any context.

Gibbs (2007) attempts to identify how the application of a sustainable development policy would assist in the governance of EIPs in the USA and in Europe. The study focused on 16 EIPs and found that most were in the early development stages. The study found that when developing EIPs, greater success would be achieved by creating linkages between existing businesses rather than creating a new business for the establishment of an EIP. The study also found that it was necessary for the existing businesses to have policies and structures available to each other to ensure better collaboration between businesses. This means that the study was limiting the development of EIP to businesses that have policies and structures, and therefore excluding informal businesses.

Hewes (2008) focused on the human side of Eco-industrial parks. The study indicated that there are significant humanistic influences throughout the Industrial Symbiosis stages. This study identified the importance of building relations between the people in EIPs as the business collaborators, and also developed the concept of an Industrial Ecology champion. The method used was the ethnographic approach, which is rooted in grounded theory, and aimed to develop an understanding the functions and role of Industrial Ecology champions. The study was conducted in Ukraine, therefore limited to that domain.

Lovelady's (2009) study focused on developing an optimization-based approach aimed towards the integration and design of an EIP. The study used various EIPs in Texas as case studies to analyse the management of wastewater. The objective of the study was to develop strategies for the recycling, reuse and separation of wastewater.

The basic focus for the study was to reduce the cost of the EIP while determining the feasible recycling and separation strategies. The study focused on EIPs that have generators and can measure the wastewater created through its production processes. The study failed to analyse waste management strategies for EIP that do not measure the wastewater created. The results of this study would then not apply to informal EIPs that lack the resources to calculate the wastewater generated and would only apply to formal EIPs.

Shi (2010) developed a case study on the Tianjin Economic-Technological Development Area (TEDA), which is based in China. The TEDA has 81 businesses in its network, which makes it one of the largest EIPs in China. The case study indicated benefits of an EIP including both environmental and economic factors. The study was based strictly on the literature and thus analysed various articles that had been published on TEDA. The study found that although TEDA remains one of the largest EIPs in China, it still suffers great competition from other developing EIPs in the country. The assessment of TEDA provided an overview of businesses in its network, which are all manufacturing businesses. The study does not provide an insight on service businesses that exist within the network of EIPs.

Sakr (2011) determined the critical success and limiting factors for the development of Eco-industrial parks. The study found that several projects in Middle East and North Africa region, specifically in Egypt, had abandoned the establishment of EIPs or neglected to complete the developments. It was further found that that the current body of knowledge on Industrial Ecology was did not provide ways to overcome the challenges that countries are faced in developing EIPs. The study was based on a case study in Egypt, and provided a blanket result that included EIP development in the Middle East. Countries face challenges based on location and resources available, therefore a finding in the Middle East and North Africa would not particularly apply in South Africa. This means that the challenges and frameworks applied would have to be rigorously tested in the region under consideration.

Behera (2012) focused on the evolution of designed Industrial Symbiosis networks in the Ulsan Eco-industrial parks. The study indicated that communication between network companies was imperative for the success of the EIP. It was, however, found that the absence of communication was prevalent in the Ulsan EIP. This then led to the development of a Research and Development into business (R&DB) framework which acts as a facilitator in expanding the company network in the EIP. It can then be concluded that for developing a designed Industrial Symbiosis, what becomes necessary is a policy instrument, a facilitator such as the EIP centre and a framework such as the R&DB.

These factors would mostly apply to networks that have developed a formal structure, that have reporting and communication channels, and that have a formal structure for daily operations. The gap in the study is that these factors have not been tested in an informal EIP.

Zhang (2013) used the Social Network Analysis to determine the network connectedness. This approach allowed the author to gain insight on the internal processes and networks. The study analysed the degree of network connectedness in 10 various EIPs in China.This was done based on products, by-products and waste. This study focused on existing EIPs and analysed the structure of each business connected on the EIP network. The study did not assess how to connect EIPs that are in the development stages, therefore a gap exists in this regard. The study further assessed EIPs that are manufacturing-based and did not assess any connectedness of businesses that are service-based, and thus another gap exists in this regard. The study found that there are *operational* challenges that exist within the EIPs based on the *structural* problems between the EIPs.

Liu (2014) stated that there was a contribution gap in the area of how a natural ecosystem can develop an Industrial Symbiosis, and further, that the interrelation between economic development and the environmental protection. This led to a development of an energy analysis-based evaluation method, which was applied on the Shenyang Economic and Technological Development Zone (SETDZ) based in China, as a case study. Results indicate that Industrial Symbiosis could effectively reduce material and energy consumption and improve overall eco-efficiency. Such a method can provide policy insights to Industrial Park managers so that they can raise appropriate strategies on development of Eco-industrial parks. Useful strategies include identifying potential Industrial Symbiosis opportunities, optimizing energy structure, increasing industrial efficiency, recovering local ecosystems, and improving public and industrial awareness of Eco-industrial park policies. An energy analysis-based evaluation method still needs to be developed locally.

Fei (2015) developed a summary of drivers and characteristics of Industrial Symbiosis in China to provide the evolution of Eco-industrial parks Industrial Symbiosis in China. The study focused on the Rizhao Economic and Technological Development Area (REDA) which comprises 31 businesses in its network. The businesses involved are manufacturing based, in cereal oil and food, machinery, pulp and paper, textile and garment, wine refining, and biomedical industries. The study failed to evaluate service businesses in the network, and further limited the evolution of EIPs to China without considering any of the other countries in BRICS.

The study found that economic benefits from EIPs required strict environmental and tax standards, and also that these would encourage stakeholder participation in Industrial Symbiosis.

Ming Pan (2016) and Yik (2017) proposed a systematic approach for the optimisation and modelling of EIPs. This approach includes building a four-level modelling framework, applying a mathematical framework describing each level of operation, developing methods for optimization problems at different levels of operation, and considering symbiotic relations between water, materials and energy networks. The objective of this paper was to explain the detailed modelling system of an EIP, and provides various optimisation strategies for a complex EIP. The study aimed specifically on EIPs that are fully developed and operational and did not develop optimising processes for developing EIPs. The study moreover did not provide guidelines on how EIPs can incorporate optimisation strategies during the conception stages. Furthermore, the study failed to address informal EIPs. Yik's (2017) optimisation design aimed at considering environmental impacts, economic performance, connectivity and network reliability. This was applied at a cooling water network.

2.5.3 **Framework Comparisons**

There are a number of frameworks that exist in the development of Eco-Industrial Park. The Kalundborg Eco-Industrial Park is the largest and most developed industrial park globally, and researchers have used it as a benchmark in the development of Eco-Industrial Parks. This section aims to discuss the framework used in development of Kalundborg Eco-Industrial Park. This section will also discuss the framework used to assist in the development of 28 EIP's globally.

2.5.3.1 ***Kalundborg Framework***

The Kalundborg Eco-Industrial Park comprises was established in 1959 and continues to grow in business networks (Ehrenfeld and Chertow, 2002). This EIP comprises of the following establishments, as indicated in figure 2.18 below.

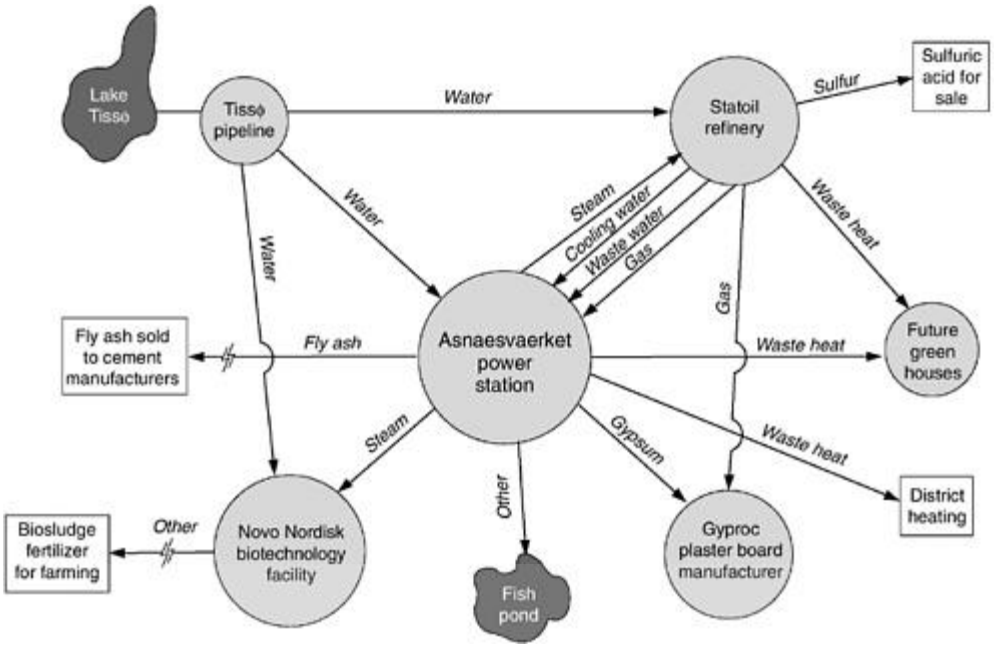

Figure 2.18 Kalundborg Eco-Industrial Park, Source (Branson, 2016)

- 1959 Asnaes Power Station commissioned
- 1961 Statoil refinery commissioned; water piped from Lake Tissø
- 1964 Original Novo Nordisk plant built
- 1972 Gyproc A/S built; excess gas piped from oil refinery
- 1973 Asnaes expands; draws water from Lake Tissø
- 1976 Novo Nordisk begins shipping sludge to farmers
- 1979 Asnaes begins to sell fly ash to cement producers
- 1981 Municipality of Kalundborg completes district heating distribution network, using steam
- 1959 Asnaes Power Station
- 1982 Asnaes delivers steam to Statoil and Novo Nordisk
- 1987 Statoil pipes cooling water to Asnaes for use as raw boiler feed water
- 1989 Fish production begins at Asnaes site, using waste heat in salt cooling water
- 1990 Statoil sells molten sulfur to Kemira in Jutland (
- 1991 Statoil sends treated waste water to Asnaes for utility use
- 1992 Statoil sends desulfurized waste gas to Asnaes; begins to use by-product to produce liquid fertilizer
- 1993 Asnaes completes flue gas desulfurization project and supplies gypsum to Gyproc
- 1995 Asnaes constructs re-use basin to capture water flows for internal use and to reduce dependency on Lake Tissø

- 1997 Asnaes switches half its capacity from coal to orimulsion; begins to send out fly ash for vanadium/nickel recovery
- 1999 A/S Bioteknisk Jordrens uses sewage sludge from the municipality of Kalundborg as a Bioremediation nutrient for contaminated soil

This EIP has been one of the most efficient in terms of environmental, social and economic sustainability. It boast as one of the largest EIP globally and one that has the most developed technologies and processes amongst its competitors (Ehrenfeld, et.al 2002).

The Kalundborg EIP was developed using a framework that focuses on two dimensions, Sustainability and Industrial Ecology (Boons, Spekkink, and Mouzakitis, 2011), this is illustrated in Figure 2.19 below.

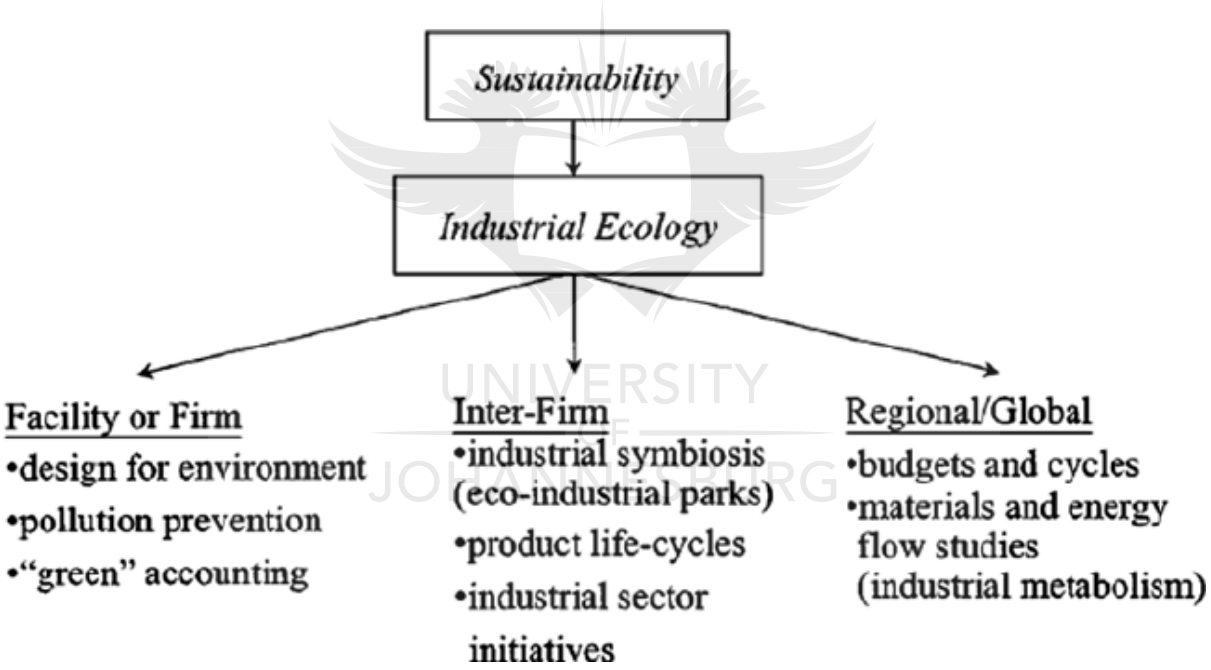

Figure 2.19 Framework used to develop the Kalundborg EIP. Source (Boons et.al 2011)

The above framework is concerned with industrial Ecology in three levels namely; the facility/firm, the inter-firm and the region. Ecology at the firm, level deals with designing operations for the sustainability of the environment, preventing pollution and accounting for all the gases released in the environment based on the business operations. The inter-firm level is concerned with Industrial symbiosis, which is the collaboration of business networks within an industrial park to ensure environmental sustainability through its operation.

Product life-cycle, which is the assessment of a product for production to consumption and disposal, and the industrial sector initiates which include efforts to reduce and eventually eliminate waste in the industrial sector as a whole. The Regional/Global level focused on budgets and cycles for the EIP, together with the material and energy flow assessment of the entire business network within the EIP.

This framework emphasis on the environmental sustainability through basic business operations and practices, which is a concept that is stressed in cleaner production. Furthermore, it can be observed that the focus is on an already developed EIP that has business networks in place and the accounting of materials and energy. This framework does not consider the development of an EIP where the business networks have not yet been established, as is the case for the Industrial Parks in Soweto. This framework, further applies to an EIP that has formalised structures in place, which is not the case for the Soweto Industrial Parks, as it is dominated by informal businesses that are yet do establish structures and formalised business practices.

2.5.3.2 *Framework for developing an EIP*

The following framework was developed to identify the characteristics of an EIP. The aim of the framework was to define the features that make up a functional and sustainable EIP (Bellantuono, Carbonara, and Pontrandolfo, 2017), see figure 2.20 below.

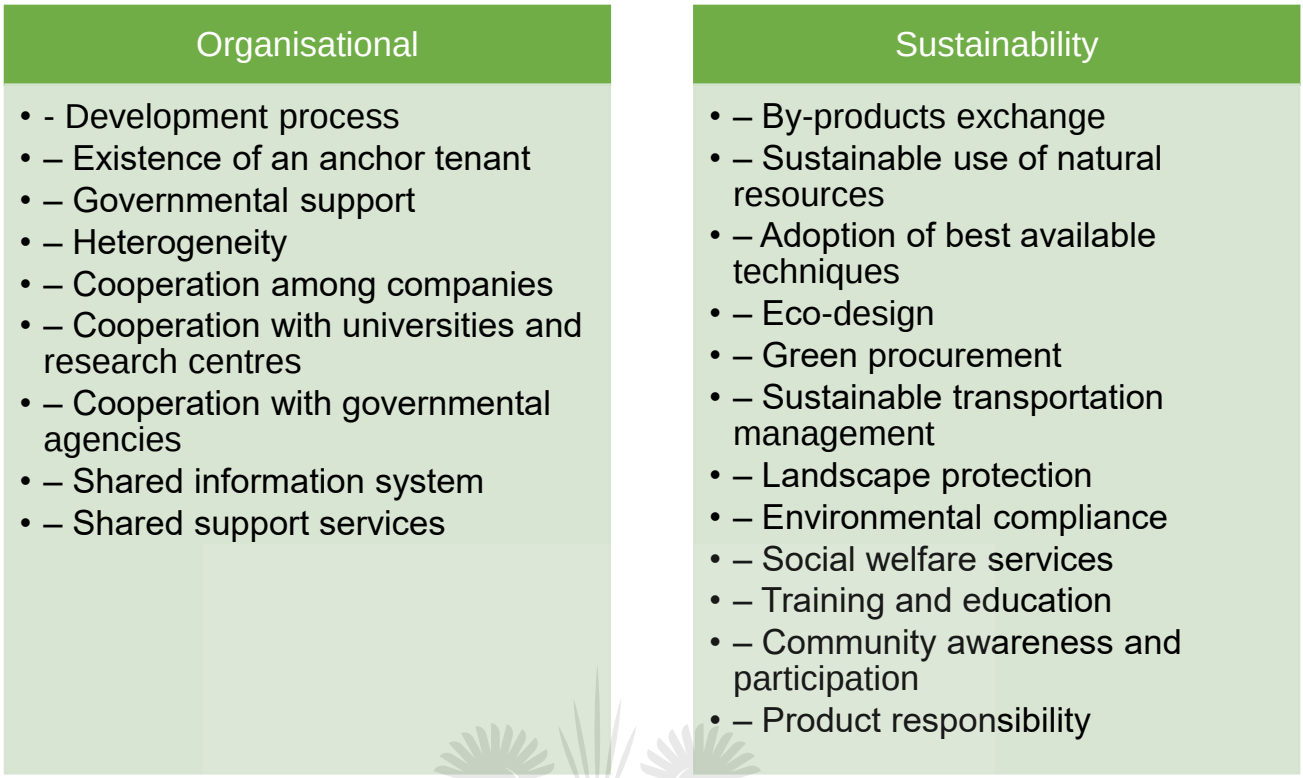

Figure 2.20 Dimensions and variables of EIP framework. Source (Bellantuono et.al, 2017)

This framework focuses on two dimensions, the Organisational and Sustainability dimension. The organisational dimension deals with various variables as indicated in figure 2.20. This framework stresses that the existence of both these dimensions would ensure that an EIP is functional and environmentally sustainable (Bellantuono et.al, 2017). Although this framework would be applicable in developing an EIP in Soweto to ensure the application of cleaner production, certain factors have not been considered, such as the informal business structures, the lack of business networks that exist in the Soweto Industrial parks. The framework further does not address how to manage waste within the EIP and how to develop the current product to be environmentally friendly while maintaining a profit for the business network.

2.5.4 **Gap Analysis**

Based on the critical analysis it emerged that most studies were conducted in the manufacturing sector, with a limited number of studies on the service sector. It is common practice globally to assess sustainability in the manufacturing sector. This is because the manufacturing sector has tangible waste material that can be assessed and calculated in terms of environmental impacts.

The absence of sustainability research in the service sector though the final product is intangible. When the human factor is present there is bound to be waste created, through paperwork, human waste, and other tangible raw materials of the operation process. The limitation of research in the service sector can be concluded as a gap in the research.

The location of where the study was conducted is very important. This is because it indicates development about Eco-industrial park in that specific location of application. Of all the assessed research papers, 37% of them were researched and applied in the United States. This included one of the best cited papers which was focused on reviewing a range of methods for supporting the creation of exchange networks in new EIPs. This paper was published in 1997 and cited 159 times. China produced 25% of the total top cited papers in the area of developing environments. This is also indicative of the development and innovation that is ongoing in China's Eco-industrial parks.

Asia has been identified as having the top three areas in which development of Eco-industrial parks can be found. 21% of the most cited papers were researched and applied in Asia. Europe has produced the largest and most innovative Industrial Symbiosis plant called the Kalundborg. This industrial park has been used as a benchmark for developing countries that aim at establishing and improving their current Industrial Parks. Only 5% of the reviewed literature was established in Egypt. This indicates that there is a dearth of papers and projects in the sub-Saharan African Region, and even more so in South Africa.

Eco-industrial park research has been commonly applied in the formal sector. This means that all the assessed research was conducted in Industrial Parks where the individual businesses were formally registered in the respective countries. Based on the analysis above, there is a dearth of studies in the informal sector. The analysis of how informal Industrial Parks can be developed is limited. This means South African EIPs will have to be designed from the bottom up.

It can be concluded that the Kalundborg EIP framework is not applicable in the development of EIP's in Soweto as it focuses on already developed EIP. The Kalundborg framework further concerns itself with EIP's that have formal business structures and practices, which are variables that still need to be developed in the Soweto Industrial Parks. The framework used to characterise features of an EIP can be applied to develop an EIP in Soweto, however it would have to be modified to ensure that it is specific to Soweto.

This framework does not address the specific business challenges that the Soweto Industrial Parks currently face which include waste management and the business development focusing on environmental and economic sustainability within the Industrial Park.

2.5.5 **Conclusion**

We know that Eco-Industrial Parks have not been developed in Soweto. It can also be concluded that informal EIPs have not been an area of focus for research. Various methods of developing EIPs have not been explored in the South African context, thus creating room for development locally.

The literature review found that while there are various frameworks that exist internationally, none of them are tailor-made for South Africa or Soweto. The literature review also clarified that there are environmental, economic and social benefits in developing EIPs. We concur that the development of a framework for Eco-Industrial Parks in Soweto is necessary to sustain the local eco-system. It can be concluded through the literature review that the objective of the study to develop an Eco-industrial park framework is valid and necessary.

3. RESEARCH METHOD

3.1 Introduction

The critical assessment conducted in Chapter 2 indicated that various gaps exist in the concept of developing EIPs and in the frameworks that currently exist in developing Eco-industrial parks. This chapter aims to address those gaps through the design of the questionnaire which takes into consideration the design of the framework based on literature, and further ensure that the objectives of the study are met through the data collection process.

This chapter focuses on the research framework which is Mixed Method, its advantages and disadvantages, the limitations of this approach, the research approach, and the research philosophy. The framework deals with how the data was collected, analysed and interpreted. The research process used in the study includes the historical comparative data, field research and the application of the questionnaire. The questionnaire was both qualitative and quantitative. All the processes that were used to gather, analyse and interpret the data are discussed.

3.2 Research Framework

The study followed the Mixed Method approach. This is a combination of both qualitative and quantitative research methods. The core characteristics of a well-designed Mixed Methods study include the following (Creswell 2004):

1) The usage of approaches that put in force qualitative and quantitative components both concurrently or sequentially, with the identical pattern or with special samples.
2) Collecting and analysing both quantitative (closed-ended) and qualitative (open-ended) information.
3) The usage of rigorous approaches in collecting and analysing records suitable to every method's tradition, together with ensuring the right sample size for quantitative and qualitative evaluation.
4) Integrating the statistics through records collection, evaluation, or discussion.
5) Framing the approaches within philosophical/theoretical models of studies, such as within a social constructionist version that seeks to recognize a several views on a single issue.

Mixed Methods research is a method for conducting research that involves collecting, analysing, and integrating quantitative and qualitative research in a single study. The purpose of this form of research is that both qualitative and quantitative research, in combination, provide a better understanding of a research problem and issue than either research approach alone.

Philosophy: Objective Epistemology was applied in the study. The researcher will not interfere with the various organisations within the observed and surveyed parks. Data will be collected and analysed without bias. Results and recommendation will be compiled based on the data collected and will reflect the nature of Industrial Parks concerned. The data collected will be used to explain the current reality in the Industrial Parks, predict and attempt to project the future of these Industrial Parks.

Approach: The study is inductive as it aims at assessing the Industrial Parks and implementing the approach to reduce the negative environmental and social impacts. The study will explore the development and implementation of EIPs in Soweto. According to Lodico *et al* (2010), inductive research is an approach in which the researcher describes a phenomenon based on observation. The study will observe what is currently practiced at the various Industrial Parks, and based on the observations will lead to the development of recommendations.

Strategy: Action research will be applied. This is a form of self-reflective enquiry undertaken by participants in sequential situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of practices and the situations in which these practices are carried out. Industrial Parks that will be surveyed include Electronic, Food, Glass, Maintenance, Metal, Textile, Plastic, Rubber, Wood, Chemicals and Construction. Transportation and logistics organisations will not form part of the survey as they do not have tangible products for assessment.

Time zones: The study will be cross sectional. This means that it the environment used for the assessment and implementation of the EIP will not be manipulated to suit the study. The factors that will be analysed and assessed for this study will only be those that have an impact on the environment ecology. The study will only take into consideration factors that have a direct impact on the environment and quality of life for the workers and communities affected by the industrial parks in Soweto.

3.2.1 Advantages of the Mixed Method

Using a Mixed Methods study has several advantages (Chounard 2008), which are noted below.

- Compares quantitative and qualitative statistics: blended strategies are mainly useful in knowledge contradictions among quantitative consequences and qualitative findings.
- Reflects members' point of view: mixed strategies deliver a voice to individuals and make certain that one looks at findings grounded in members' experiences.
- Fosters scholarly interplay: such research adds breadth to multidisciplinary team studies by encouraging the interaction of scholars using quantitative, qualitative, and combined techniques.
- Offers methodological flexibility: combined techniques have significant flexibility and are adaptable to many designs, including observational research and randomized trials, to clarify extra statistics that may be acquired in best quantitative studies. It collects rich, comprehensive records.

3.2.2 Limitations of the Mixed Method

Mixed Methods studies are challenging to implement, especially when they are used to evaluate complex interventions (Čížek 2009). Several challenges are noted below.

- Mixed Methods research is complicated to devise and conduct. It requires cautious planning to describe all factors of studies, which include the observed pattern for qualitative and quantitative quantities (equal, embedded, or parallel); timing (the series of qualitative and quantitative portions); and the plan for integrating records.
- Integrating qualitative and quantitative records throughout analysis is mostly a tough challenge for plenty of researchers. It is based on a multidisciplinary team of researchers. Engaging in Mixed Methods studies calls for a multidisciplinary team of researchers who, inside the provider of the biggest, have a look at, and should be open to methods that won't be their area of expertise.
- Finding qualitative experts who are also at ease discussing quantitative analyses and vice versa may be difficult in lots of environments. This is because every approach should adhere to its very own standards for rigour, ensuring appropriate placement of every factor of a combined methods examine may be difficult.

- Embedded samples, wherein a qualitative subsample is embedded within a bigger quantitative pattern, may be beneficial in instances of insufficient statistical strength. This calls for accelerated resources.
- Mixed strategies research is labour extensive and require extra sources and time to carry out.

3.3 Research Process

Data for this study will be collected using Historical Comparative Data, field research and questionnaires. These techniques are explained below.

3.3.1 Historical Comparative Research

The researcher, through this technique, was able to examine aspects of the Industrial Parks. This technique helped the researcher to build on theory that already existed within the industry and also informed relevant and significant in terms of Eco-industrial park. The type of historical data varied from published journals, to relevant textbooks and other articles that are focused on the national and global Eco-industrial parks frameworks. This technique combines theory that already exists on the subject together with the data collected by the researcher. The researcher was able to compare the frameworks that were used to develop Eco-industrial parks and evaluate the operations of the Industrial Parks in the past; this allowed for a clear identification of the best framework to be used for this research. Limitations of this technique is that certain information is protected and not available for public viewing. Questionnaires were used in such cases.

3.3.2 Field research

The researcher observed the operations at the Industrial Park and interacted with the members of the Park. During these observations, the researcher focussed intensely on how the Park employees handle the waste from operations in the Park, while relating that to the design of EIPs. Field research is usually used for exploratory and descriptive studies; therefore, this type of data collecting technique was best suited for this study. Field research allows the researcher to have first-hand experience. This however, can at times be seen as intrusive by the workers. The workers were notified about the observations that would be taking place, which made them feel as though they are a crucial part of the observation process.

3.3.3 Questionnaires

Questionnaires were distributed to each business in any identified Industrial Park in Soweto. A total of 139 questionnaires were distributed. The questionnaire included open-ended and closed-ended questions. The structure of the questions were designed in such a way that allows easy completion by the business owners. The questions were structured based on the critical analysis that identified the gap in Chapter 2.

3.3.3.1 Likert Scale

A Likert scale was used in designing the questionnaire. This included a five point scale of Never, Seldom, Sometimes, Often and Always. The scales used further included, Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. The Likert scale is popularly used as it provides a good method of analysing data when compared to other scales, according to Boone (2012). This is because it allows a range of answers for respondents compared to other scales and thereby ensuring that the answers received are reliable.

3.3.3.2 Questionnaire layout and design

The questionnaire was divided into two sections. Section A was concerned with the demographics of the businesses, which included the gender, age, qualifications and the number of years that the business has been in operation in the current Industrial Park. Section B was derived from the literature review and the objectives of the study. This section included the type of raw materials that the businesses use, the type of waste that is produced, challenges faced with waste management, opportunities available in managing waste, stakeholder and community support, and potential benefits and advantages of creating Industrial Symbiosis through the development of an Industrial Park. The questionnaire further addressed the likelihood of developing such a park in Soweto.

The questionnaire distribution was conducted based on the gaps identified through the critical assessment in Chapter 2. The first gap that was identified was that there was no study recorded in Soweto on the development of Industrial Parks. The questionnaire was then distributed in Soweto in order to close the gap. The second gap that was identified was that the Industrial Parks that were aimed to be developed were largely formal Industrial Parks. The questionnaire then focused on both formal and informal Industrial Parks, as indicated in Table 3.1 below.

Table 3. 1 Structure of the business

Structure of the business					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Formal	53	38,1	43,1	43,1
	Informal	70	50,4	56,9	100,0
	Total	123	88,5	100,0	
Missing	System	16	11,5		
Total		139	100,0		

More than half of the questionnaires were distributed to informal Industrial Parks, and about 38% were distributed to formal Industrial Park networks.

The questionnaire was distributed to the following main businesses in Industrial Parks in Soweto as indicated in Table 3.2 below;

- Craft
- Traditional medicine
- Spaza shop
- Street vendor
- Metal work
- Hair Dressing and Nails
- Shebeen
- Mechanics
- Clothing and Textile
- Tyre sales and repairs
- Cobbler
- Wholesale
- Tile and flooring
- Carpenter

Table 3. 2 Type of businesses in Soweto Industrial Parks.

		Frequency	Percent	Cumulative Percent
Valid	Craft	10	7,2	7,2
	Traditional medicine	6	4,3	11,5
	Spaza shop	5	3,6	15,1
	Street vendor	4	2,9	18,0
	Metal work	17	12,2	30,2
	Hair Dressing and Nails	10	7,2	37,4
	Shebeen	9	6,5	43,9
	Mechanics	15	10,8	54,7
	Clothing and Textile	9	6,5	61,2
	Tyre sales and repairs	10	7,2	68,3
	Cobbler	6	4,3	72,7
	Wholesale	3	2,2	74,8
	Tile and flooring	6	4,3	79,1
	Carpenter	9	6,5	85,6
	Other	20	14,4	100,0
	Total	**139**	**100,0**	

The study found that there were other businesses that existed within the industrial park, that were not mentioned on the list on the questionnaire, these businesses include the following as indicated in Table 3.3 below.

Table 3. 3 Other businesses found in Soweto Industrial Parks.

Business		Frequency	Percent	Cumulative Percent
Valid	Other	119	85,6	85,6
	Bakery	1	0,7	86,3
	Big bags manufacturer	1	0,7	87,1
	Butchery	1	0,7	87,8
	Car wash	1	0,7	88,5
	Chicken farm	1	0,7	89,2
	Cooking shop	1	0,7	89,9
	Digital media	1	0,7	90,6
	Dog houses manufacturer	1	0,7	91,4
	Dry cleaners	1	0,7	92,1
	Foam mattress	1	0,7	92,8
	Foam mattress manufacturer	1	0,7	93,5
	Fridge repairers	1	0,7	94,2
	Glass manufacturer	1	0,7	95,0
	Liquid soap manufacturer	1	0,7	95,7
	Paint manufacturer	1	0,7	96,4
	Paper manufacturer	1	0,7	97,1
	Plastic manufacturer	1	0,7	97,8
	Tag manufacturer	1	0,7	98,6
	Tombstone manufacturer	1	0,7	99,3
	Upholstery	1	0,7	100,0
	Total	**139**	**100,0**	

The gap analysis further found that there was minimal attention given to the service-based businesses in Industrial Parks. The researcher then aimed to bridge this gap by including businesses that focus on services when distributing the questionnaire. The questionnaire was then distributed to 35% of service providing businesses, as indicated in Table 3.4 below.

Table 3. 4 Type of Organisation.

		Frequency	Percent
Valid	Manufacturing	84	60,4
	Service	49	35,3
	Total	133	95,7
Missing	System	6	4,3
Total		139	100,0

3.4 Data analysis

The data obtained from the qualitative section of the questionnaires was analysed using the qualitative data analysis method developed by Wierman (2005). The steps for this method are as follows:

1. Thoroughly examine all the records, and write down thoughts.
2. Write down the views on each document, while focusing on the underlying meaning.
3. Create a list of all topics, enter these articles into columns as main titles, detailed subjects and non-relevant topics.
4. Minimize headings and write codes next to the appropriate parts of the text. Be careful if new class codes appear.
5. Find the most descriptive name for the subjects and reduce the complete list of classes by combining related topics
6. Abbreviate each class and list codes in alphabetical order.
7. Combine each class information in one place and make an initial assessment
8. Record the data.

This process will allow for further quantitative analysis, which will be handled by Statkon.

3.4.1 Statkon

The completed questionnaires will be captured and analysed using the Statistical Package for the Social Science software (SPSS). SPSS is one of the most common statistical packages, which achieves multifaceted data handling and analysis with simple commands.

SPSS has a variety of statistical and mathematical functions, statistical procedures, and flexible data handling capability. This software is able to read data in any format (e.g., numeric, alphanumeric, binary, dollar, date, time formats) (SPSS, 2012). This software will be used to analyse the quantitative data into information from the 139 respondent's questionnaires.

Two main statistical methodologies were used in data analysis: descriptive statistics and Exploratory factor analysis, which draws conclusions from data that are subject to random variation (e.g., observational errors, sampling variation). Descriptive statistics deals with two arrangements of properties of a test or populace. The focal propensity (or area) looks to describe the appropriation's focal value, and portrays the degree to which individuals from the dissemination leave from its centre and one another. Exploratory factor analysis identifies the lowest number of mutual elements that will interpret the correlation.

3.4.2 Exploratory factor analysis

Factor analysis is concerned with decreasing dimensionality (Bartholomew, 2011). This is when quantifiable and apparent variables can be decreased to lesser variables that share a mutual variance. These apparent factors are not directly valued; however, they are important paradigms that characterise the variables. Exploratory factor analysis is concerned with identifying factors that influence variables and classifying which go together (Yong, 2013). The aim of Exploratory Factor analysis is to identify the lowest number of mutual factors that will interpret the correlation.

The study used exploratory factor analysis for the raw materials used, the waste produced, the challenges of waste management and the waste management techniques in Industrial Parks in Soweto. The study found four factors for the raw materials used in Industrial Parks, three factors for the waste produced in Industrial Parks, three factors for challenges of waste management and the waste management techniques used in the Soweto Industrial Parks.
The study was conducted using the exploratory factor analysis using the five step process based on (Pallant, 2007). See Figure 3.1 below.

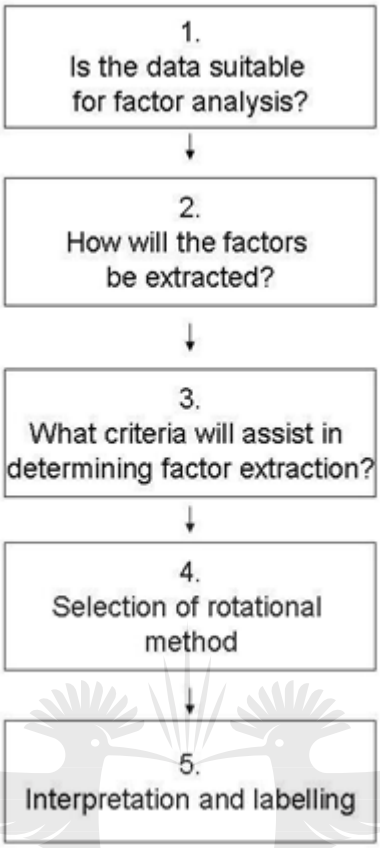

Figure 3.1 Five step process for conducting the exploratory factor analysis (Pallant, 2007)

3.4.2.1 Step 1: Ensuring that the data is appropriate to extract a factor

a) Sample size and sample to variable ratio

According to Williams (2010) a sample of 100 or more is recommended to conduct a factor analysis. This study used a sample of 139 cases to conduct the factor analysis, and this provided valid and robust results.

The sample to variable ratio refers to the number of participants required for an individual variable. There are various opinions about the adequate sample to variable ratio. However a consensus has emerged that there is no minimum level for the ratio to conduct a good factor analysis (Hogarty, 2005)

b) Factorability of the correlation matrix

A correlation matrix displays the relationship between the single variables in an exploratory factor analysis. Williams (2010) states that if there are no correlations above 0.30 then factor analysis should not be used.

This means that a minimum correlation of 0.30 is required for the factor analysis to be considered valid. A correlation of 0.30 means that the factors account for about 30% of the relationship between the variables, and thus it is unfeasible to determine if the variables correlate with each other. The correlation matrix was found to be above 0.30 in the study and therefore validating the relationship between variables, and validating the factors identified throughout the study.

c) Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy/Bartlett's Test of Sphericity

Various tests are conducted before the factors are extracted (Pallant, 2007). These tests include the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

Table 3.5 Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartletts Test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.536
Bartlett's Test of Sphericity	Approx. Chi-Square	2 582.571
	df	1225
	Significance.	.000

The KMO values range between 0 to 1. Factor analysis is considered when it is 0.50 or below. The Bartlett's test is considered significant when the value is below 0.5, this means that factor analysis can be considered, as is illustrated in Table 3.5.

3.4.2.2 Step 2: Extraction of factors

The goal of rotation is to streamline the structure of a collection of items. This means that items with high loadings are placed on one factor and items with smaller loadings are placed on other factors. The study used principal component analysis (PCA) to extract items.

Pett (2003) regards the principal component analysis as a default method and therefore becomes commonly used. He also indicated that this method be used when there is no theory or model that exists to guide the study. For this reason the principal component analysis was pertinent for this study. The study aimed to create a framework for the Industrial Parks in Soweto, and thus PCA was applicable.

3.4.2.3 Step 3: Criteria used to determine factor extraction

The purpose of extracting data is to lower the number of items into factors. Williams (2010) holds that various approaches should be used to extract data to ensure the validity of the factors. The study used the parallel analysis, scree test and the cumulative percent of variance to determine the factors. The approaches successfully defined the factors based on the items that were available, which then allowed the researcher to compile the framework necessary.

a) Cumulative Percentage of Variance and Eigenvalue > 1 Rule

Based on the Cumulative Percentage of Variance Criteria, when a minimum of 95% of the variance are explained and then the factors should be stopped according to Williams (2010). Nevertheless this depends on the field of the study being conducted. Table 3.6 below indicates a total of 7 factors with an eigenvalue > 1, and a cumulative percentage of variance of 40.6%

Table 3. 6 Total Variance Explained (SPSS Output).

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	19.095	40.627	40.627	19.095	40.627	40.627
2	2.644	5.625	46.252	2.644	5.625	46.252
3	1.733	3.688	49.940	1.733	3.688	49.940
4	1.354	2.882	52.822	1.354	2.882	52.822
5	1.156	2.459	55.281	1.156	2.459	55.281
6	1.144	2.433	57.714	1.144	2.433	57.714
7	1.014	2.158	59.873	1.014	2.158	59.873

Extraction Method: Principal Component Analysis.

b) Scree Test

As noted by Thompson (1996) interpreting Scree plots is subjective, requiring researcher judgement. So, disagreement over which factors should be retained is often open for debate Although this disagreement and subjectivity is reduced when sample sizes are large, *N:p* ratios are (>3:1) and communalities values are high.

Inspecting and interpretation of a Scree plot involves two steps (Pallant, 2007):

- Draw a straight line through the smaller eigenvalues where a departure from this line occurs. This point highlights where the debris or break occurs. (If the Scree is messy, and difficult to interpret, additional manipulation of data and extraction should be undertaken.)
- The point above this debris or break (not including the break itself) indicates the number of factors to be retained.

In the example below (see Figure 3.2), the inspection of the Scree plot and eigenvalues produced a departure from linearity coinciding with a 6-factor result. Therefore, this Scree Test indicates that the data should be analysed for 6 factors.

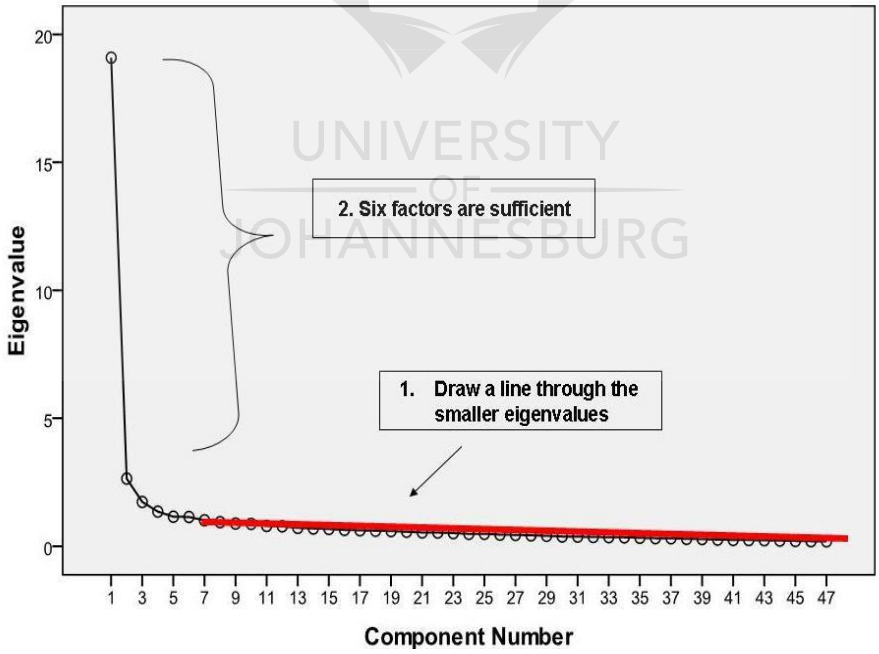

Figure 3.2: Scree Test Criterion *(SPSS Output)*

c) Parallel Analysis

Parallel analysis is an under-used factor extraction technique and is often not reported in the literature. One possible reason for its limited use is that the analysis is not available in conventional statistical programmes such as SPSS, However, authors suggest that parallel analysis has both merit and application in extracting factors Thompson (1996) (See Table 3.7. below.

Table 3. 7 Parallel Analysis (Monte Carlo PA Output) adapted from Williams (2010)

Component Number	Actual eigenvalue from PCA	Random order from parallel analysis	Decision
1	14.947	3.2670	Accept
2	4.714	3.0052	Accept
3	3.025	2.8050	Accept
4	2.312	2.6318	Reject
5	2.204	2.4668	Reject
6	1.940	2.3386	Reject
7	1.893	2.2110	Reject
8	1.546	2.0936	Reject
9	1.375	1.9715	Reject
10	1.287	1.8606	Reject
11	1.265	1.7701	Reject
12	1.133	1.6712	Reject
13	1.020	1.5861	Reject

Following these analyses, a final number of factors is presented. The researcher required careful judgement on which of the factors extracted make the most conceptual sense.

3.4.2.4 Step 4: Selection of Rotational Method

The study used the Orthogonal Varimax rotation, which has been labelled the most common rotational method in factor analysis (Thompson, 1996). This rotation method develops factor structures that are uncorrelated. The aim of a rotational methods is to provide results that can be interpreted easily. Once the rotation of variance was complete, the researcher was able to identify the items that do not fit into any factor and assess whether those items should be ignored or considered.

3.4.2.5 Step 5: Interpretation

This step involved the labelling of factors by assigning a name to all the identified factors. Based on Henson and Roberts (2006), the labelling process is subjective to the researcher and the theory.

This means that the researcher develops the names of the factors based on their own understanding of the factors, and the theory they have been exposed to in relation to the items that make up the factors. The interpretation of these factors was further used to develop the framework for the study in Chapter 6.

3.5 Conclusion

This chapter addressed the research method used in the study. The research framework and design were discussed, and the analysis and interpretation of data were addressed. The chapter further discussed the techniques used to gather the data, which included the design and distribution of the questionnaires, the use of factor analysis and its application. The chapter addressed how the gaps identified in Chapter 2 would be covered and how they would be interpreted.

In Chapter 4, the results found based on the research method used will be discussed. That chapter will explain the findings and their implications while further indicating the current status of Industrial Parks in Soweto based on waste production, waste management and the potential for development Eco-industrial parks.

4. RESULTS

4.1 Introduction

This section is divided into two sections. Section 4.2 deals with the results from using the descriptive analyses. This analysis is based the demographics of the Industrial Parks concerned, which include gender, age and education level. This section also describes the types of businesses that these parks are involved in, how long the businesses have been in operation, and the businesses structures and activities related recycling and waste management. Section 4.3 is concerned with the exploratory factor analyses. This section provided results on Correlation metrics, Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, Bartlett's Test of Sphericity, Pattern Metrics, Screen Plot Eigenvalue and the variance of eigenvalues. This section additionally labels the factors and provides the mean, standard deviation and ranking for each factor variance.

4.2 Descriptives

A total number of 139 Industrial Parks participated in the study. It was found that 106 of these Industrial Parks were owned by males and only 32 Industrial Parks were owned by females, Figure 4.1.

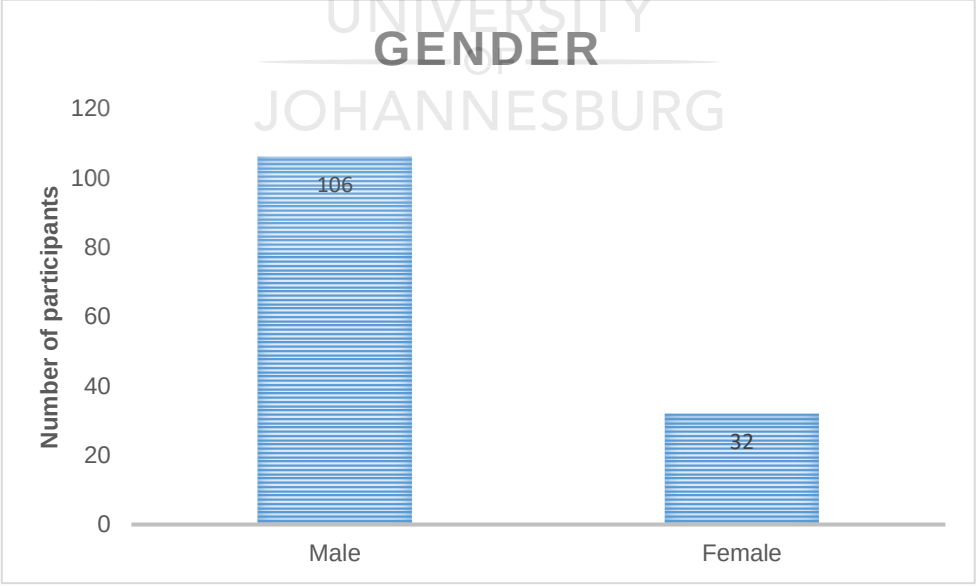

Figure 4.1 Gender distribution of respondents.

The low number of female participation in Industrial Parks shows that there is minimal development of female skills within the parks. The high number of male-owned Industrial Parks indicates that many of the industrial jobs are still regarded as male orientated positions, this puts the development of women in the area at a disadvantage.

The ages of the participants ranged between 18 to above 46 years, Figure 4.2. It was found that three respondents were between 18-24, 25 respondents were between 25 -31 years, 40 respondents between 32-38 years, 46 respondents between 39-45 years, and 24 respondents were above 46 years in age.

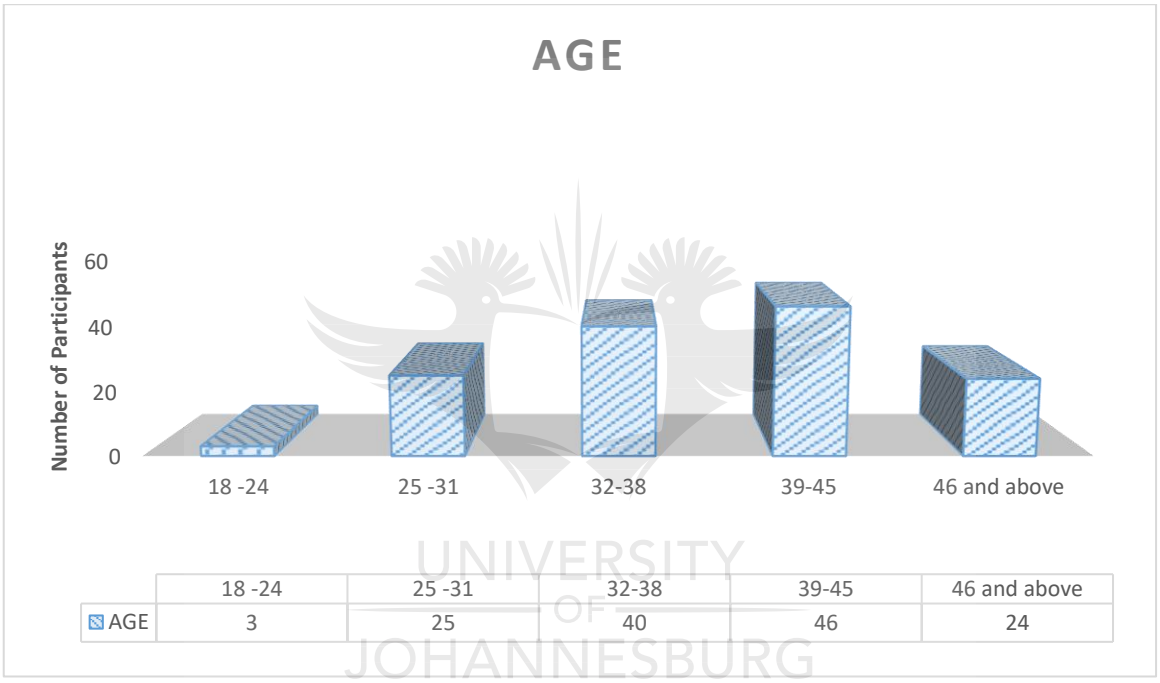

Figure 4.2 Age distribution of respondents.

The highest number of respondents was between 32 – 45 years. This shows that many of these businesses are established and run by people that are approaching the end of their youth age of 33, based on the South African context, and at this stage businesses are at their peak. Respondents between the ages 25-31 and 46 and above, showed a close correlation, which also meant that these were the phases before the peak and after the peak of the business performance.

The level of education for the respondents was assessed in five categories; Grade 11 (standard 9) or lower, grade 12 (Matric/standard 10), Post Matric Diploma or Certificate, Baccalaureate Degree(s), and Post-graduate Degree(s) as seen in Figure 4.3 below.

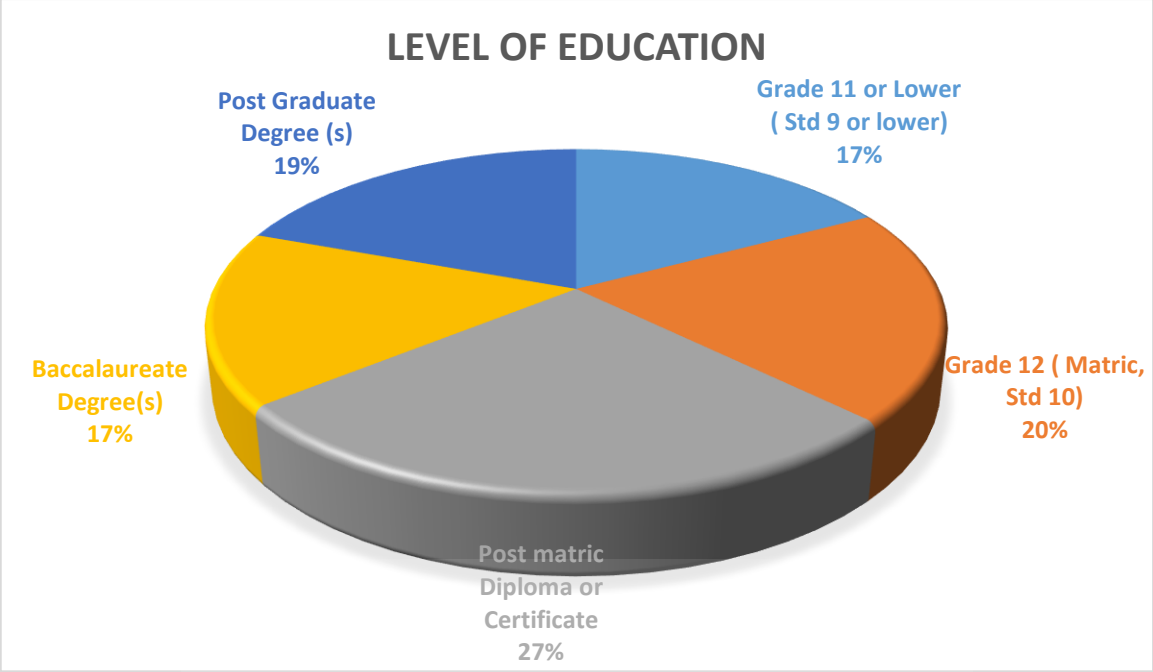

Figure 4.3 Levels of education

The level of education with the highest percentage was found to be the Post-Matric Diploma or Certificate level, with a total of 26.9%. it was then followed by the Grade 12 or Matric level with 20.1%. The Post-graduate degree reflected a 19.4%, grade 11 or lower, was 17.2%, and the lowest percentage was from the Baccalaureate Degree with 16.4 %. It was found that people with Grade 12 or Matric, Certificates and Diplomas have more businesses in Industrial Parks compared to people Baccalaureate degrees and Post-graduate degrees. It was also found that people with Grade 11 and lower have more businesses specifically when compared to people with Baccalaureate degrees. This indicated that people with lower education levels had more technical skills compared to people with a higher education level.

The type of businesses that were found in the Industrial Parks varied. A majority of these businesses were focused in car mechanics and metal work, as can be seen in Table 4.1 below.

The other businesses that were found were; Craft makers, Traditional medicine manufacturers, Spaza shops, Street vendors, Hair Dressers, Shebeens, Clothing and Textile, Tyre sales and repairs, Wholesale cobblers, Tile and flooring, Carpenters, Bakery, Bin bags manufacturer, Butchery, Car Wash, Chicken farm, Cooking shop, Digital media, Dog houses manufacturer, Dry cleaners, Foam mattress, Foam mattress manufacturer, Fridge repairers, Glass manufacturer, Liquid soap manufacturer, Paint manufacturer, Paper manufacturer, Plastic manufacturer, Tag manufacturer, Tombstone manufacturer and Upholstery. This can be seen on Table 4.1 below.

Table 4. 1 Types of businesses in Industrial Parks.

Part A		Frequency	Percent	Cumulative Percent
Valid	Craft	10	7,2	7,2
	Traditional medicine	6	4,3	11,5
	Spaza shop	5	3,6	15,1
	Street vendor	4	2,9	18,0
	Metal work	17	12,2	30,2
	Hair Dressing and Nails	10	7,2	37,4
	Shebeen	9	6,5	43,9
	Mechanics	15	10,8	54,7
	Clothing and Textile	9	6,5	61,2
	Tyre sales and repairs	10	7,2	68,3
	Cobbler	6	4,3	72,7
	Wholesale	3	2,2	74,8
	Tile and flooring	6	4,3	79,1
	Carpenter	9	6,5	85,6
	Other	20	14,4	100,0
	Total	139	100,0	

Part B		Frequency	Percent	Cumulative Percent
Valid	Other	119	85,6	85,6
	Bakery	1	0,7	86,3
	Big bags manufacturer	1	0,7	87,1
	Butchery	1	0,7	87,8
	Car wash	1	0,7	88,5
	Chicken farm	1	0,7	89,2
	Cooking shop	1	0,7	89,9

	Digital media	1	0,7	90,6
	Dog houses manufacturer	1	0,7	91,4
	Dry cleaners	1	0,7	92,1
	Foam mattress	1	0,7	92,8
	Foam mattress manufacturer	1	0,7	93,5
	Fridge repairers	1	0,7	94,2
	Glass manufacturer	1	0,7	95,0
	Liquid soap manufacturer	1	0,7	95,7
	Paint manufacturer	1	0,7	96,4
	Paper manufacturer	1	0,7	97,1
	Plastic manufacturer	1	0,7	97,8
	Tag manufacturer	1	0,7	98,6
	Tombstone manufacturer	1	0,7	99,3
	Upholstery	1	0,7	100,0
	Total	139	100,0	

The types of businesses identified are largely technical and are labour intensive. These require a specific hand-crafting skill. It was interesting to find that most of the people with such skills have a lower education level compared to those without these skills.

The number of years that businesses have been operations was categorised as follows; 0 – 3 years, 3 - 6 years, 6 – 9 years, 9 -12 years, 12 years and above, see Figure 4.4 below.

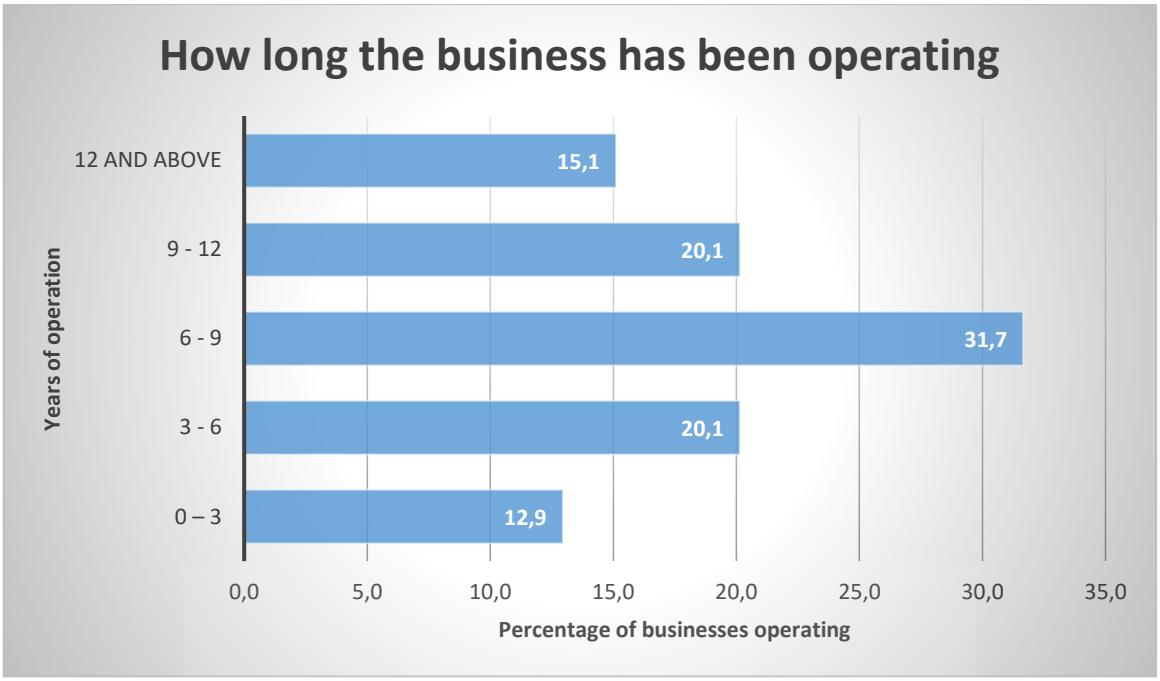

Figure 4.4. Number of years the business has been in operation.

12.9 % of the businesses were found to be operating between 0 – 3 years, 20.1% were found to be operating between 3 - 6 years, 31.7% were found to be operating between 6 – 9 years, 20.1 were found to be operating between 9 – 12 years and 14.1% had been in operation for more than 12 years. The largest percentage was found between 6 – 9 years in operation, this was much longer than other periods. This meant that after the 9th year of operation, there were fewer businesses found in Industrial Parks compared to before the 9th year of operation. This number decreases even more after the 12th year of operation.

The study identified through the gap analysis in Chapter 2,that studies relating to Eco-industrial park development were largely based on the manufacturing organisations and not much was found in the service organisations. The study then attempted to investigate the type of organisations that exist within the Industrial Parks in Soweto, with the aim to have some level of focus on the service organisations. (See Table 4.2 below.)

Table 4. 2 Type of organisations within the Industrial Parks in Soweto.

Type of organization					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	84	60,4	63,2	63,2
	Service	49	35,3	36,8	100,0
	Total	133	95,7	100,0	
Missing	System	6	4,3		
Total		139	100,0		

It was found that 36.8% of organisations within the Industrial Parks are service-based and 63.2% were manufacturing based. This finding means that the study will then be able to develop a framework that closes the gap that was identified in Chapter 2, as it will be able to focus on both manufacturing and service, thus adding to the body of knowledge.

The study further found, through Chapter 2, that the development of Eco-industrial park was largely focused on formal organisations within Industrial Parks, and then explored the type of organisations that exist within the Industrial Parks in Soweto, see Figure 4.4 below.

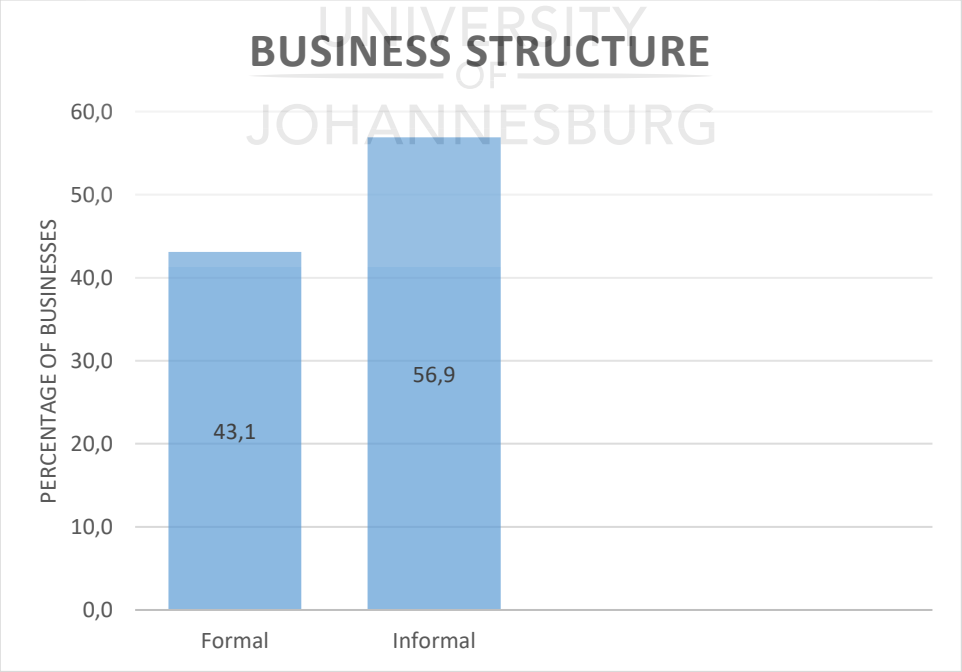

Figure 4.4. Structure of businesses found in Industrial Parks in Soweto

It was established that 43.1% of businesses that exist within the Industrial Parks in Soweto are formal and 56.9% of the businesses are informal. Formal businesses are those that are registered and pay business tax. However informal businesses are not registered and do not pay any business tax. Most of these informal businesses stated that they work with their hands, and pay for the energy that they use, and felt there was no need to be registered. Some of these include, cobblers, carpenters, mechanics, metal workers and hairdressers.

Businesses were asked whether they recycle the waste produced by their businesses and how much of the overall waste produced was being recycled, and this is indicated in Figures 4.6 and 4.7 below.

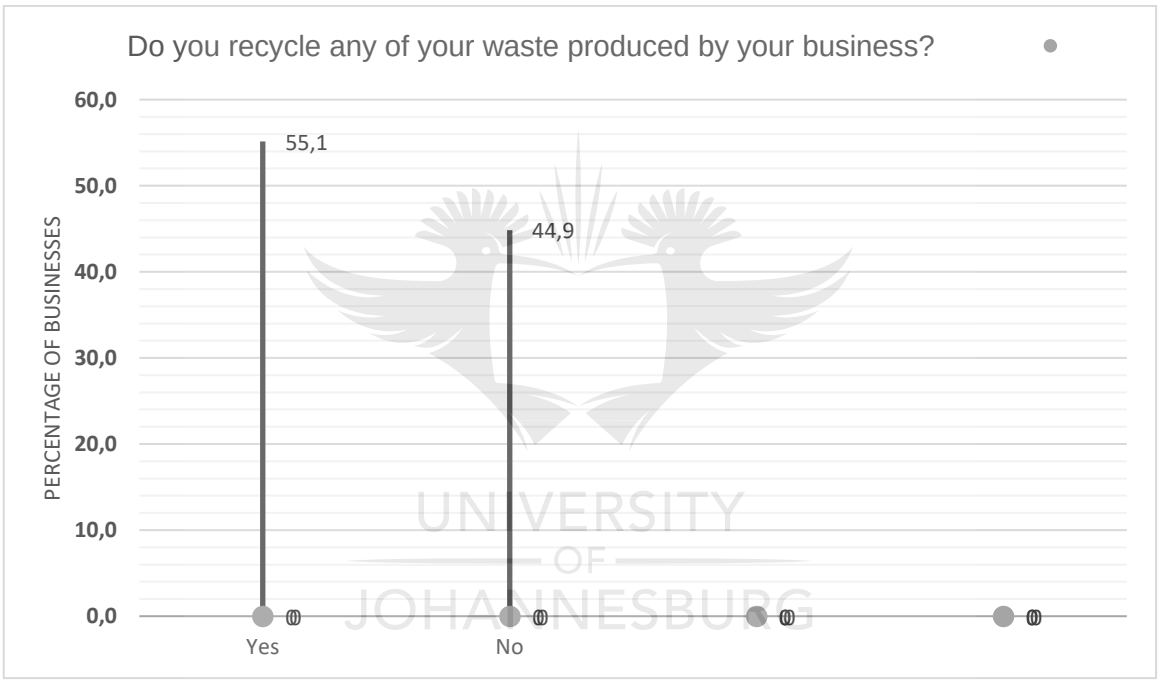

Figure 4.6 Businesses that recycle waste.

55.1% of the businesses within the concerned Industrial Parks stated that they recycle the waste that the business produces, and almost 45% indicated that they do not recycle any of the waste produced. Although the number of businesses that recycle is larger than those that do not recycle, the level of non-recyclers is still concerned that this does not contribute to the creation of a green environment.

Based on the number of businesses that recycle their business waste, the study further strived to find out how much of the overall waste was being recycled in terms of percentage.

The categories were classified as follows; less than 25% is being recycled, 25% - 50% is being recycled, 50% - 75% is being recycled, 100% is being recycled, as can be seen in Figure 4.7 below.

Figure 4.7. Amount of overall business waste being recycled.

Although businesses indicated that they do recycle their waste, only 1.3% of the businesses recycled all the waste produced in their businesses. This value was followed by 13.3% of businesses that recycle 75% or more of the overall business waste produced. 20% of the businesses indicated that they recycle 50-75% of their overall waste, 24% recycle 25-50%, and a majority of 41.3% of businesses recycle less than 25% of their overall waste produced. So most of the businesses are not much concerned with recycling waste. This may be due to a limited amount of knowledge they have in terms of how to recycle, or a limited interest and focus on recycling initiatives.

It was imperative for the researcher to find out if the businesses within the Industrial Parks in Soweto, were anticipating any future growth in their businesses, see Figure 4.8 below. This was essential as it helps to identify opportunities for how they would be able to handle the waste that the businesses produce, and further also helps identify the type of skills necessary for such growths in those businesses.

Figure 4.8. Planned upcoming growth in the businesses

It was found that only 26% of all the businesses that were involved in the study were planning on growing their businesses, and a large 74% did not anticipate any growth in their businesses. The businesses that saw a lack of growth in the future of their businesses indicated that they had been doing the same thing for more three years, and do not see any better way to do their jobs. This indicates a lack of skills development and exposure in terms of business processes and applications in the current market. Table 4.3 below, further probed on the type of development and growth that these businesses had planned.

Table 4. 3 Type of growth the business is foreseeing

Type of growth in the businesses.					
Description		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No response	120	86,3	86,3	86,3
	I am adding 4 more tables and 16 more chairs from 1st December	1	0,7	0,7	87,1
	I am building a braai area outside my butchery	1	0,7	0,7	87,8
	I am opening a new branch in a different location	1	0,7	0,7	88,5
	I am opening a new store in Katlehong in the East Rand	1	0,7	0,7	89,2
	I have applied for a contract to supply a cleaning company	1	0,7	0,7	89,9
	I hope to open a new division for low cost material in my business	1	0,7	0,7	90,6
	I just bought three new machines and I am currently training people to use them	1	0,7	0,7	91,4
	I normally employ an extra worker during peak seasons like December holidays	1	0,7	0,7	92,1
	I plan on extending my working hours to accommodate the festive season demand	1	0,7	0,7	92,8

	I plan to create more products in the coming 6months to take to exhibitions for a sale	1	0,7	0,7	93,5
	I plan to hire 2 more mechanics in the next 6 months	1	0,7	0,7	94,2
	I want to create more crafts and sell more than I currently do	1	0,7	0,7	95,0
	I want to train and employ a temporary hairdresser in December	1	0,7	0,7	95,7
	I am extending my store to add more shelves for the bakery section	1	0,7	0,7	96,4
	I am extending my working space no accommodate new products	1	0,7	0,7	97,1
	I am in the process to add vegetables to my stock	1	0,7	0,7	97,8
	I am receiving training on making storage boxes which I plan also to sell	1	0,7	0,7	98,6
	We are opening a new branch in the Johannesburg CBD	1	0,7	0,7	99,3
	We are starting to make wooden tiles in January 2019	1	0,7	0,7	100,0
	Total	139	100,0	100,0	

The various types of businesses had various types of plans, from simple to complex. The type of growths identifies were as follows:

- Adding 4 more tables and 16 more chairs from 1st December
- Building a braai area outside the butchery
- Opening a new branch in a different location
- Opening a new store in Katlehong in the East Rand
- Applied for a contract to supply a cleaning company
- Hope to open a new division for low cost material in the business
- Bought 3 new machines and I am currently training people to use them
- Employ an extra worker during peak seasons like December holidays
- Extending working hours to accommodate the festive season demand
- Create more products in the coming 6 months to take to exhibitions for a sale
- Hire 2 more mechanics in the next 6 months
- Create more crafts and sell more than currently
- Train and employ a temporary hairdresser in December
- Extending the store to add more shelves for the bakery section
- Extending working space to accommodate new products
- Adding vegetables to my stock
- Receiving training on making storage boxes which will be sold in the store
- Opening a new branch in the Johannesburg CBD
- Starting to make wooden tiles in January 2019

Some of the business developments intend to move away from the Industrial Park concept and aim to focus on being individual stores outside of the Industrial Park network. This would create a big challenge for these businesses as they would have to draw customers solely on their own without any assistance from the Industrial Park network.

The researcher aimed to find out whether organisations were currently selling any of their waste in the Industrial Park, or buying waste from other businesses in the park; see Figure 4.9 below.

Do you currently buy or sell waste?

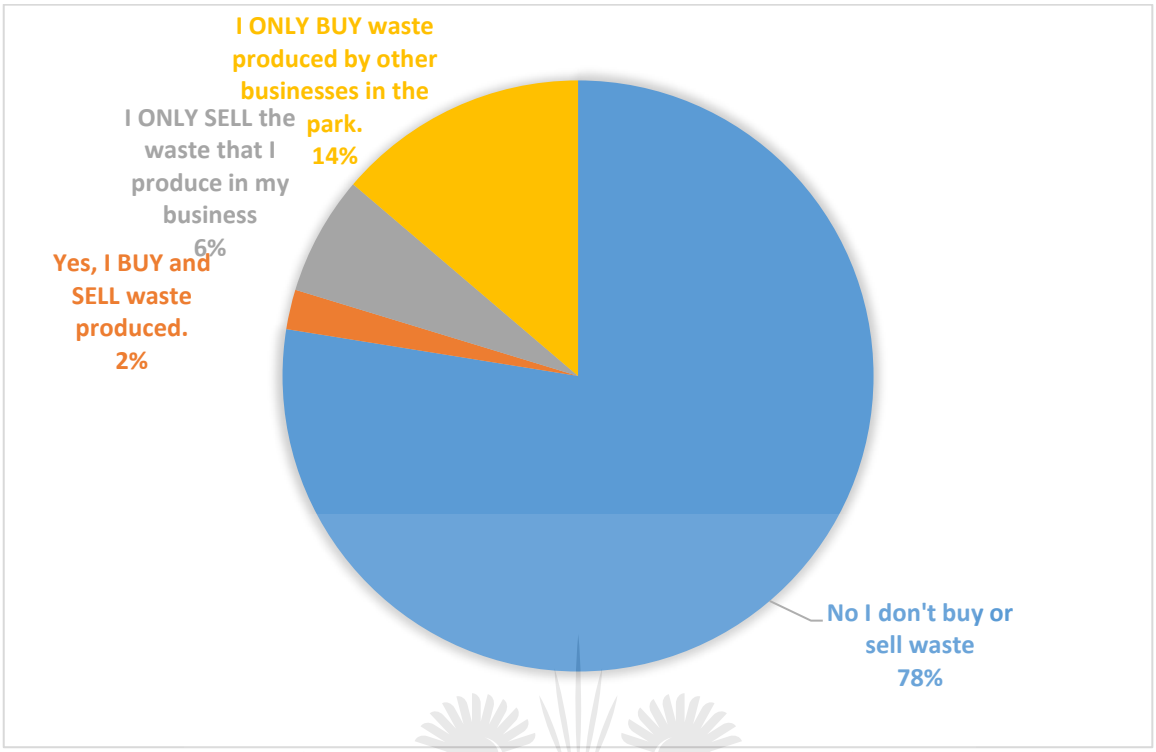

Figure 4.9. Businesses that buy and/or sell their waste

A majority (78%) of the businesses stated that they do not buy or sell their waste. 14% indicated that they only buy waste produced by other businesses in the park, 6% stated that they only sell the waste that their businesses produce to other businesses in the park, and only 2% of the overall businesses both buy and sell waste produced in businesses from the park. These figures indicate that only a minimal number of businesses in Industrial Parks are concerned about the management of business waste. Furthermore, the 78% value of businesses that neither buy or sell waste produced in the Industrial Park, shows that there is an opportunity available for these businesses to either buy and/or sell waste to generate revenue and create an environmentally friendly Industrial Park.

Although Figure 4.9 indicates that most businesses in the Industrial Park do not buy or sell their waste, the study investigated whether these specific businesses were aware if other businesses in the park buying or selling waste. This is shown in Figure 4.10 below.

Figure 4.10. Awareness of other businesses buying or selling waste.

When businesses were asked whether they were aware of any other businesses in the park that buy or sell waste, the numbers were evenly distributed. 23,2% reported that they were no businesses at the time that either buy or sell waste at the park. 26,8% reported that there were businesses that sell waste in their Industrial Park, 26,1% indicated that there were businesses that buy waste in their Industrial Park, and 23,9% were not aware if there were any businesses that either buy or sell waste in the Industrial Park.

These values indicate that there is generally an awareness within the Industrial Parks about buying or selling waste, while the level of participation in either buying or selling waste is relatively low. To assess the benefits of buying waste (see Figure 4.11 below), the businesses in the Industrial Parks in Soweto, were requested to state whether they think they could benefit strictly from buying waste, and further how they believe they could benefit from this, Table 4.4.

Do you think your business can benefit from buying waste from other businesses in the park?

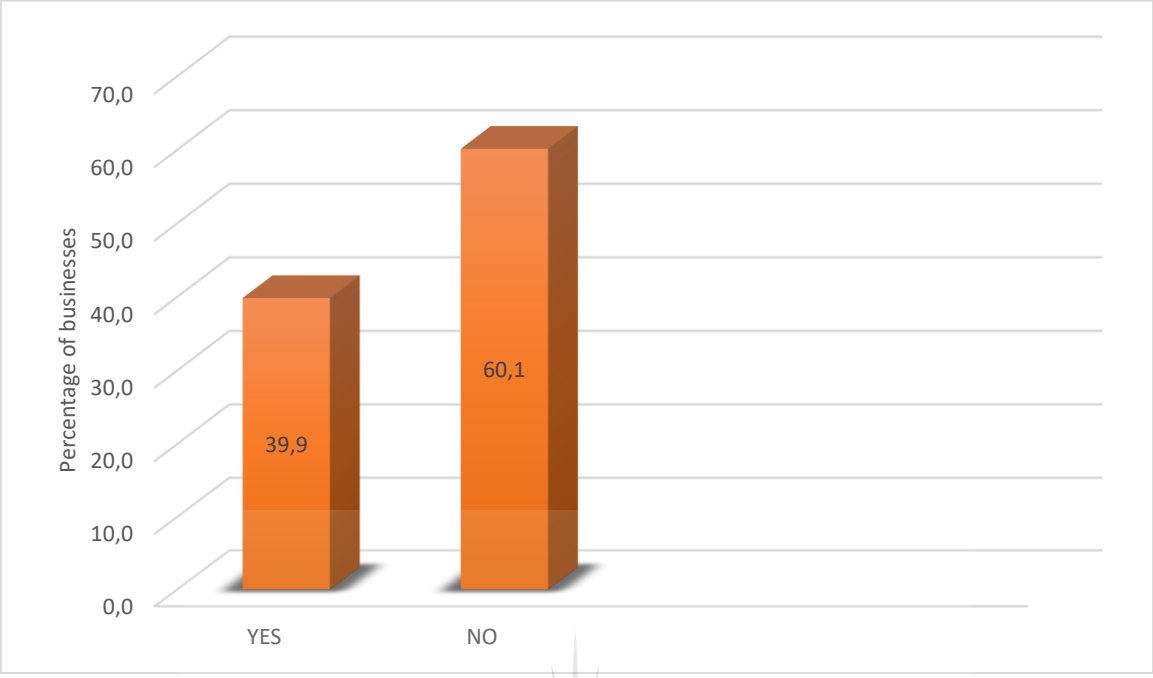

Figure 4.11. Perceived level of benefit from buying waste in the Industrial Parks

A minimum number of businesses in the Industrial Park indicated a belief that they could benefit from buying waste. 60,1% stated that the do not think they can benefit from buying waste and 39,9% stated that they think they can benefit from buying waste in the Industrial Parks. Although the level of awareness in terms of buying and selling waste was high within the parks, the study found that the businesses are still not aware of the benefit that these activities may bring, especially in buying waste from other businesses. The businesses that stated that they think they can benefit from buying waste in Industrial Parks, provided the following details in terms of how they think their businesses from benefit from such activities: see Table 4.4 below.

Table 4. 4 How businesses can benefit from buying waste in the Industrial Parks.

How businesses can benefit from buying waste in the Industrial Parks.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid					
	I buy empty bottles from households	1	0,7	0,7	74,8
	I buy old couches and fix and resell them at a better price	1	0,7	0,7	75,5
	I buy old metal and renew it	1	0,7	0,7	76,3
	I buy old plastic products from domestic household transform and sell them	1	0,7	0,7	77,0
	I buy old tyres	2	1,4	1,4	78,4
	I buy old tyres to fix new ones	1	0,7	0,7	79,1
	I buy old wood to make my crafts	1	0,7	0,7	79,9
	I buy used wood	1	0,7	0,7	80,6
	I buy wood from tree cutters to make my products	1	0,7	0,7	81,3
	I can buy damaged crafts and renew them	1	0,7	0,7	82,0
	I can buy old furniture and renew it for sale	1	0,7	0,7	82,7
	I can buy old shoes to fix new shoes instead of buying new raw materials	1	0,7	0,7	83,5

	I can buy old steel metal and renew it	1	0,7	0,7	84,2
	I can buy rubber soles for cheaper prices	1	0,7	0,7	84,9
	I can buy wood at a cheaper price	1	0,7	0,7	85,6
	I can finance my raw materials	1	0,7	0,7	86,3
	I can get the parts at a cheaper price	1	0,7	0,7	87,1
	I can grow my business	1	0,7	0,7	87,8
	I can have more plastics and papers to use for my herbs instead of buying them	1	0,7	0,7	88,5
	I can open a scrap shop	1	0,7	0,7	89,2
	I can save money in my raw materials	1	0,7	0,7	89,9
	I can sell more products from the extra-raw materials	1	0,7	0,7	90,6
	I can spend less on raw materials	1	0,7	0,7	91,4
	I can use old fabric for new designs	1	0,7	0,7	92,1
	I could have more raw materials on hand	1	0,7	0,7	92,8
	I could use old material to train workers instead of new material that is expensive	1	0,7	0,7	93,5

	I currently buy empty bottles and plastics	1	0,7	0,7	94,2
	I use old metal to make new products	1	0,7	0,7	95,0
	I will buy cheaper parts fix them and resell them	1	0,7	0,7	95,7
	I would be able to access more metal	1	0,7	0,7	96,4
	I would have a lot more raw materials	1	0,7	0,7	97,1
	I am not sure how I will benefit	1	0,7	0,7	97,8
	It would give me an opportunity to interact with other mechanics	1	0,7	0,7	98,6
	It would make it easier to get metal	1	0,7	0,7	99,3
	We use torn tyres to repair	1	0,7	0,7	100,0
	Total	139	100,0	100,0	

Here are some of the ways in which they think they might benefit from buying waste in the Industrial Park;

- I can buy damaged crafts and renew them
- I can buy old furniture and renew it for sale
- I can buy old shoes to fix new shoes instead of buying new raw materials
- I can buy old steel metal and renew it
- I can buy rubber soles for cheaper prices
- I can buy wood at a cheaper price
- I can finance my raw materials
- I can get the parts at a cheaper price
- I can grow my business
- I can have more plastics and papers to use for my herbs instead of buying them

- I can open a scrap shop
- I can save money in my raw materials
- I can sell more products from the extra-raw materials
- I can spend less on raw materials
- I can use old fabric for new designs
- I could have more raw materials on hand
- I could use old material to train workers instead of new material that is expensive
- I would buy cheaper parts fix them and resell them
- I would be able to access more metal
- It would give me an opportunity to interact with other mechanics
- It would make it easier to get metal

These businesses provided a practical way of how buying waste can directly and financially benefit them. This indicates that there is an opportunity to expose these businesses to each other so that they could buy waste from each other within the Industrial Park. This will reduce the amount of waste that is disposed of, and also provide financial benefits for these businesses.

The prospects of buying waste were revealed above. The study also found what the thoughts were about selling waste in the Industrial Parks, and this is reflected in Figure 4.12 and Table 4.5 below.

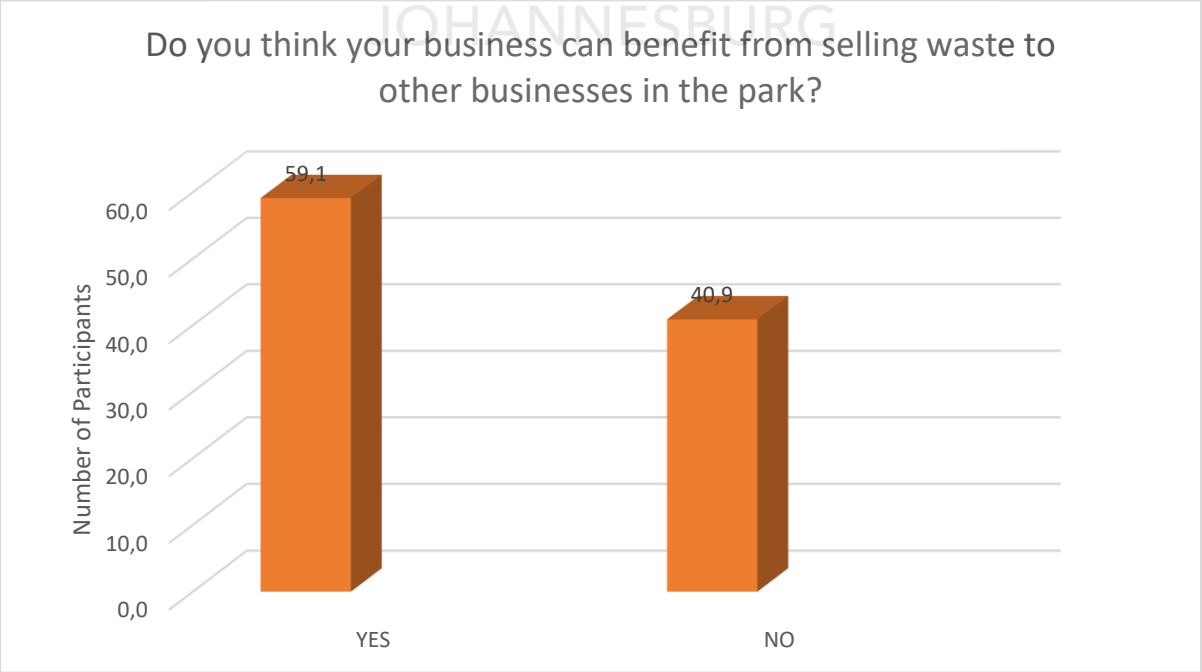

Figure 4.12 Perceived level of benefit from selling waste in the Industrial Parks.

Figure 4.11 shows that businesses in Industrial Parks in Soweto mostly do not think they can benefit from buying waste, while the opposite is reflected in Figure 4.12 in terms of selling waste. Almost 60% of the businesses stated that they believe that their businesses could benefit from selling waste. This means that 40,9% believe that they would not benefit from selling waste. The businesses that do believe they could benefit from selling waste were not aware of how they could sell their waste, and also indicated that they do not know if any business would be interested in buying waste from them. So there is a lack of information in terms of how waste can be sold to benefit the businesses and the environment.

Table 4.5 below shows how businesses believe they can benefit from selling waste to other businesses in the Industrial Parks in Soweto.

Table 4. 5 How businesses can benefit from buying waste in the Industrial Parks.

COMMENTS		Frequency	Percent	Cumulative Percent
Valid	By selling cans I make money for my business and get discount on my stock	1	0,7	56,1
	I can be able to buy more machinery in my business	1	0,7	56,8
	I can be able to order more stock for my stock	1	0,7	57,6
	I can buy old car batteries and renew them	1	0,7	58,3
	I can employ more people to assist with the workload	1	0,7	59,0
	I can employ more workers during the festive season	1	0,7	59,7
	I can finance other things I need in my store	1	0,7	60,4
	I can generate more income in my business	1	0,7	61,2
	I can get rid of the broken tiles at a price	1	0,7	61,9
	I can have a new stream of income	1	0,7	62,6
	I can hire more people to do the work	1	0,7	63,3
	I can hire someone to sell the waste and pay them from it	1	0,7	64,0
	I can make extra money for my business	1	0,7	64,7
	I can make money from selling broken car parts	1	0,7	65,5
	I can make money from the pieces that I don't use	1	0,7	66,2
	I can make more money in my business	1	0,7	66,9
	I can open a waste department	1	0,7	67,6

	I can open a new waste department	1	0,7	68,3
	I can reduce waste the waste I need to remove	1	0,7	69,1
	I can remove the excess waste on my premises	1	0,7	69,8
	I can sell leftover wood instead of burning it	1	0,7	70,5
	I can sell my scrap metal parts and make additional money	1	0,7	71,2
	I can sell my tyre pieces and make more money	1	0,7	71,9
	I can sell my waste and clean up my premises	1	0,7	72,7
	I can sell the leftover foam to the other upcoming business and create a collaboration with them	1	0,7	73,4
	I can sell the scrap that I normally throw away	1	0,7	74,1
	I can use any means of extra income in my business	1	0,7	74,8
	I can use my waste as an income generator	1	0,7	75,5
	I could sell them at a cheaper price and make money for my business	1	0,7	76,3
	I exchange old parts for cash to buy new parts	1	0,7	77,0
	I give away my waste it would be an advantage to sell it	1	0,7	77,7
	I have damaged plastic bottles that are pilling up space	1	0,7	78,4

	I have fabric that I dont know what to do with that is leftover from other products	1	0,7	79,1
	I normally throw away left over material selling it would be a good substitute	1	0,7	79,9
	I sell beer bottles and cans to make extra money	1	0,7	80,6
	I sell broken car parts to the scrap-yard	1	0,7	81,3
	I sell cans and bottles that I collect from cars to pikit up	1	0,7	82,0
	I sell empty bottles to the bottle store	1	0,7	82,7
	I sell plastic that cannot be re melted	1	0,7	83,5
	I sometimes sell zinc leftovers to people in the camps to patch their roofs	1	0,7	84,2
	I will be able to remove the containers in my premises by selling them	1	0,7	84,9
	I would be able to grow my business	1	0,7	85,6
	I would be able to buy second hand car parts cheaper	1	0,7	86,3
	I would be able to expand my operations	1	0,7	87,1
	I would be able to remove some of the waste from my premises	1	0,7	87,8
	I would be able to sell more things in my business	1	0,7	88,5
	I would like to make more money in my business	1	0,7	89,2

	I would sell instead of dumping it	1	0,7	89,9
	Instead of storing and burning boxes I can sell them	1	0,7	90,6
	Instead of storing it can sell it	1	0,7	91,4
	It can generate more money in my business	1	0,7	92,1
	It can help finance my new branch	1	0,7	92,8
	It can help us deal with the high volume of glass waste produced	1	0,7	93,5
	It would help the business financially in this current economic climate	1	0,7	94,2
	It would reduce the attraction of thieves in my business	1	0,7	95,0
	It would reduce the bad smell	1	0,7	95,7
	It would reduce the waste that I have to store before removal	1	0,7	96,4
	It would reduce the waste that is stored on my premises	1	0,7	97,1
	Sometimes we don't know what to do with some of the waste selling it would help us keep our premises clean	1	0,7	97,8
	We could hire more administration staff members	1	0,7	98,6
	We have a lot of waste on the premises and it increases during municipal strikes I would appreciate any new initiative that would help me reduce it	1	0,7	99,3

	We sell our waste to pawn shop	1	0,7	100,0
	Total	139	100,0	

Here are some of the ways businesses provided concerning ways they think they can benefit from buying waste in the Industrial Park;

- I can sell the leftover foam to the other upcoming business and create a collaboration with them
- I can sell the scrap that I normally throw away
- I can use any means of extra income in my business
- I can use my waste as an income generator
- I could sell them at a cheaper price and make money for my business
- I exchange old parts for cash to buy new parts
- I give away my waste it would be an advantage to sell it
- I have damaged plastic bottles that are piling up space
- I have fabric that I don't know what to do with that is left over from other products
- I normally throw away left over material selling it would be a good substitute
- I sell beer bottles and cans to make extra money
- I sell broken car parts to the scrapyard
- I sell cans and bottles that I collect from cars to Pik-It-Up
- I sell empty bottles to the bottle store
- I sell plastic that cannot be re melted
- I sometimes sell zinc leftovers to people in the camps to patch their roofs
- I will be able to remove the containers in my premises by selling them
- I would be able to grow my business
- I would be able to buy second-hand car parts cheaper
- I would be able to expand my operations
- I would be able to remove some of the waste from my premises
- I would be able to sell more things in my business
- I would like to make more money in my business
- I would sell instead of dumping it

- Instead of storing and burning boxes I can sell them
- Instead of storing it can sell it
- It can generate more money in my business
- It can help finance my new branch
- It can help us deal with the high volume of glass waste produced
- It would help the business financially in this current economic climate
- It would reduce the attraction of thieves in my business
- It would reduce the bad smell
- It would reduce the waste that I have to store before removal
- It would reduce the waste that is stored on my premises
- Sometimes we don't know what to do with some of the waste selling it would help us keep our premises clean
- We could hire more administration staff members
- We have a lot of waste on the premises and it increases during municipal strikes I would appreciate any new initiative that would help me reduce it

The study found that most of the businesses have a clear understanding of how selling waste to other businesses in the park can benefit them, and also have interest in selling waste. It was however also found that businesses lack the networking ability with each other within the parks, which would enable an opportunity to sell and buy waste to and from each other.

As the study's objective was to develop an Eco-industrial park in Soweto, the researcher aimed to find out if the businesses in the current Industrial Parks understood the concept of an Eco-industrial park, as illustrated in Figure 4.13 below.

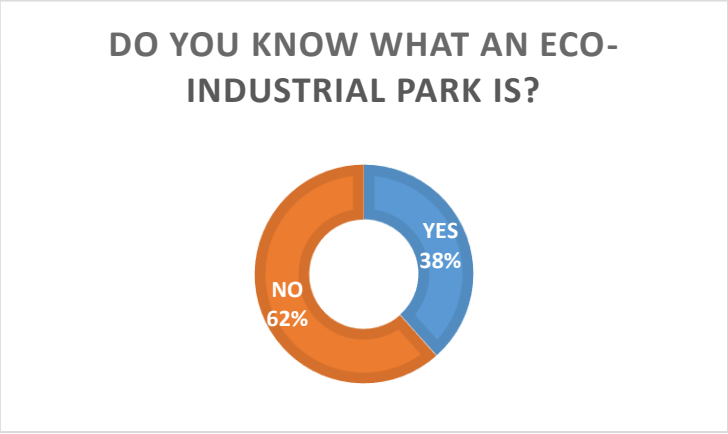

Figure 4.13 Knowledge of the Eco-industrial park concept in Soweto Industrial Parks.

The study found that 62% of the businesses in the Industrial Parks do not know what an Eco-industrial park is, and only 38% understood what an Eco-industrial park is. These values were of concern and indicated that there is a major need for training and development in the understanding of an Eco-industrial park, its operations and its benefits for individual businesses and the collective Industrial Parks. Given that the majority that lack knowledge, most companies do, however, understand the concept of a green economy.

Developing an Eco-industrial park requires a business-friendly location. The study investigated whether the current location of these Industrial Park was conducive to create a green environment, see Figure 14.4 below.

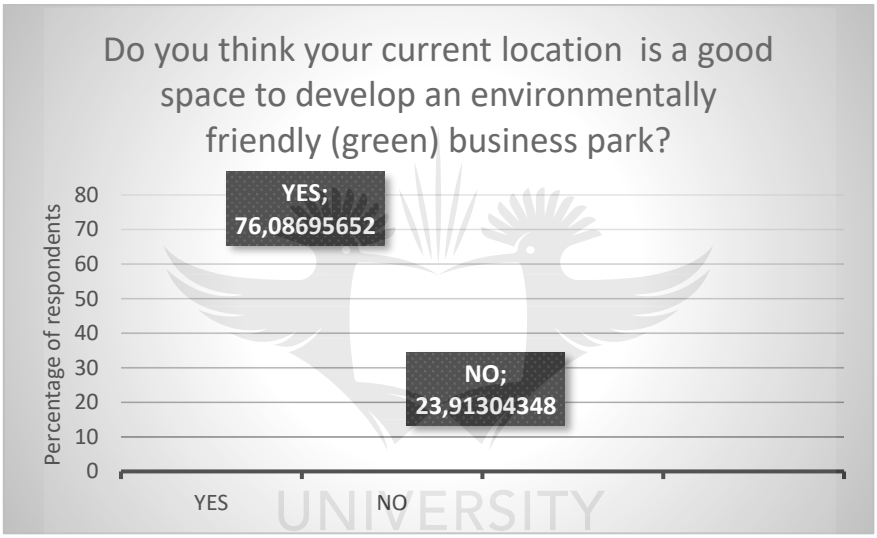

Figure 4.14 Prospects of developing an environmentally friendly business park in the current location.

76% of the businesses in Industrial Parks in Soweto stated that their current location was conducive to develop an Eco-industrial park, and 24% stated that their locations were not favourable for the development of an Eco-industrial park. These figures are favourable and indicate that there is a possibility for the development of Eco-industrial parks in Soweto.

4.3 Section 4.3: Exploratory Factor Analysis

4.3.1 Exploratory Factor Analysis on raw materials in Soweto Industrial Parks

The Exploratory Factor Analysis results based on the list of raw materials that are used in Industrial Parks are presented below in Table 4.6, a total number of 12 items were identified to be the raw materials that are used in development of products in Industrial Parks in Soweto.

Table 4. 6 Variables that constitute the raw materials used in Soweto Industrial Parks.

Variable
Rubber
Plastic
Steel
Paper
Glass
Wood
Boxes
Fabric
Gas
Water
Liquid Chemical
Powder Chemical

The raw materials include the following; Rubber, Plastic, Steel, Paper, Glass, Wood, Boxes, Fabric, Gas, Water, Liquid Chemical and Powder chemical.

A correlation matrix describes the relationship between the items. The relationship could be either negative or positive, table 4.7. When the relationship is positive, this means that that the items move in the same direction, however when the relationship is negative, this means that the one items value increases while the other decrease

Table 4. 7 Correlation Matrix on Raw Materials

Correlation Matrix													
		Rubber	**Plastic**	**Steel**	**Paper**	**Glass**	**Wood**	**Boxes**	**Fabric**	**Gas**	**Water**	**Liquid Chemical**	**Powder Chemical**
Correlation	Rubber	1,000	0,043	0,266	0,098	0,259	0,096	0,120	0,230	0,378	0,017	0,092	0,157
	Plastic	0,043	1,000	0,314	0,427	0,128	0,159	0,345	0,077	0,042	0,000	0,105	0,093
	Steel	0,266	0,314	1,000	0,226	0,000	0,070	0,219	0,099	0,368	0,111	0,128	0,026
	Paper	0,098	0,427	0,226	1,000	0,113	0,053	0,375	0,011	0,074	0,040	0,098	0,151
	Glass	0,259	0,128	0,000	0,113	1,000	0,019	0,257	0,210	0,019	0,011	0,148	0,198
	Wood	0,096	0,159	0,070	0,053	0,019	1,000	0,040	0,083	0,106	0,106	0,075	0,096
	Boxes	0,120	0,345	0,219	0,375	0,257	0,040	1,000	0,037	0,027	0,032	0,185	0,012
	Fabric	0,230	0,077	0,099	0,011	0,210	0,083	0,037	1,000	0,128	0,092	0,110	0,121
	Gas	0,378	0,042	0,368	0,074	0,019	0,106	0,027	0,128	1,000	0,149	0,140	0,115
	Water	0,017	0,000	0,111	0,040	00,01	0,106	0,032	0,092	0,149	1,000	0,430	0,433
	Liquid Chemical	0,092	0,105	0,128	0,098	0,148	0,075	0,185	0,110	0,140	0,430	1,000	0,602
	Powder Chemical	0,157	0,093	0,026	0,151	0,198	0,096	0,012	0,121	0,115	0,433	0,602	1,000

The Correlations indicated coefficients higher that 0.3 in Table 4.7. This means that the strength of the inter-correlations between the items is high, and therefore it is acceptable.

The Cronbach Alpha indicates the closeness of items and their reliability as indicated in Table 4.8. When the Cronbach value is above 0.7, then the items tested are proven to be reliable and acceptable.

Table 4. 8 Cronbach's Alpha

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0,847	0,760	12

The study found that the Cronbach Alpha value for the items that make up the raw materials was 0.8, which means that the items can be accepted and that they are reliable.

The accepted Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value is 0.6, which was surpassed as a value of 0.618 was found, as indicated in Table 4.9. The Bartlett's Test of Sphericity was also found to be acceptable as it was below 0.05, therefore validating the acceptability of the correlation matrix.

Table 4. 9 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,618
Bartlett's Test of Sphericity	Approx. Chi-Square	297,002
	df	66
	Significance	0,000

The eigenvalue was set at 1.0, as presented in Table 4.9 below. Five factors were identified to have eigenvalues that are above 1, and this is illustrated in Figure 4.15, which also shows the excluded factors that were below the value of 1.0

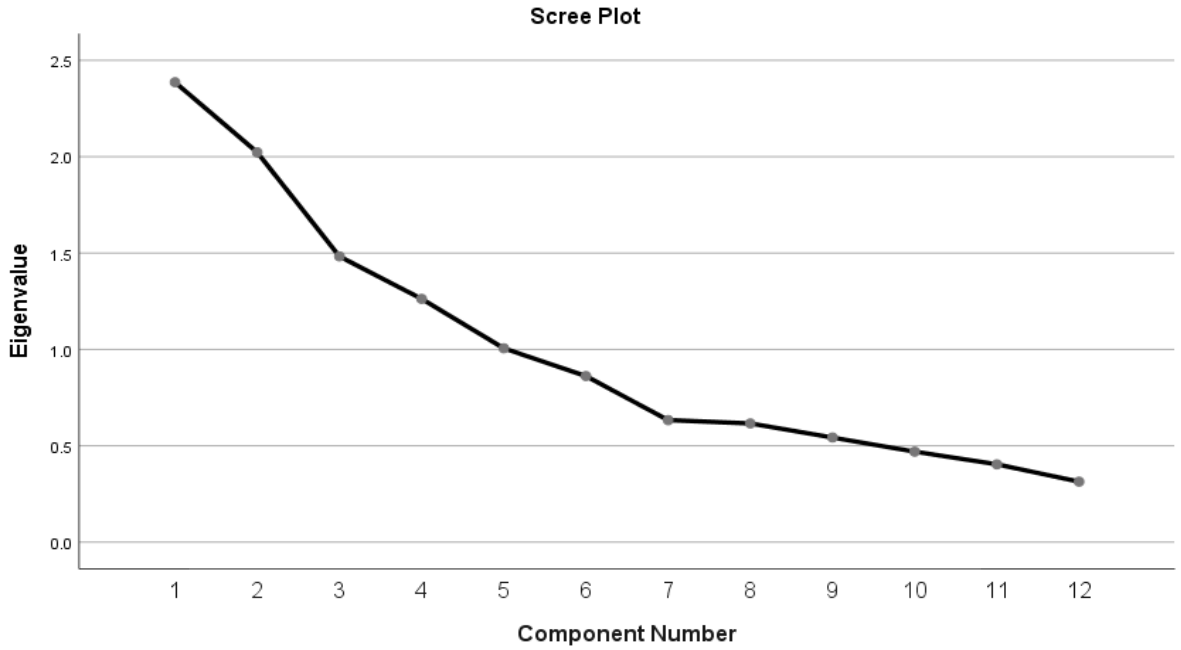

Figure 4.15: Screen Plot Eigenvalue

Table 4. 10 Pattern Matrix

Pattern Matrix				
	Component			
	1	2	3	4
Liquid Chemical	0,825			
Water	0,805			
Powder Chemical	0,782			
Paper		0,813		
Plastic		0,730		
Boxes		0,713		
Gas			0,829	
Steel			0,727	
Rubber			0,619	
Glass				0,758
Fabric				0,670

Table 4. 11 Total Variance Explained

Total Variance Explained							
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2,386	19,886	19,886	2,386	19,886	19,886	2,037
2	2,022	16,853	36,739	2,022	16,853	36,739	2,018
3	1,483	12,357	49,095	1,483	12,357	49,095	1,721
4	1,262	10,520	59,615	1,262	10,520	59,615	1,531
5	1,006	8,381	67,996	1,006	8,381	67,996	1,166
6	0,862	7,180	75,176				
7	0,633	5,275	80,452				
8	0,616	5,135	85,586				

Each factor that was extracted had a different eigenvalue to the next; see Table 4.11 above.

The values were as follows; Factor 1 had a value of 19.89%, Factor 2 was 16.85, Factor 3 12.36%, Factor 4 10.52%. The total value for all the extracted factors was valued at approximately 68% of the total cumulative variance.

- Factor 1*: Water and Chemicals*

The principles that conclude factor 1 were named water and chemical. This factor was characterised by three principles named liquid chemical (82.5%), water (80,5%) and Powder chemical with 78.2%, as indicated in table 4.9. The percentage of variance for this factor was 19.89% as indicated in Table 4.11.

- Factor 2: *Paper and Packaging*

Factor 2 was named paper and packaging. This factor was made up of three principles, Paper (81.3%), Plastic (73.0%), and Boxes (71.3%) 4.9%. the percentage of variance for this factor was 16.85%, as indicated in Table 4.11.

- Factor 3: *Energy and Metal*

Factor 3 was made up of three principles. This factor was named energy and metal. The principles that make up this factor are Gas (82,9%) Steel (72.7%) and Rubber (61,9%). These percentages are found in Table 9. The percentage of variance for this factor was 12.36%, as found in Table 4.11.

- Factor 4: *Secondary Resources*

Factor 4 was named secondary resources is made up of three principles in table 4.9, are Glass (75,8%) and Fabric (67,0%). The percentage of variance, found in Table 4.11, was 10,52%.

Table 4. 12 Ranking of Raw Materials

Item	Mean ($\bar{x}$)	Standard Deviation (σX)	Ranking (R)
Liquid Chemical	3,81	1,377	1
Water	3,31	1,346	2
Powder Chemical	3,05	1,558	3
Paper	2,94	1,325	4
Plastic	2,81	1,513	5
Rubber	2,68	1,433	6
Steel	2,54	1,621	7
Boxes	2,01	1,504	8
Fabric	1,93	1,520	9
Wood	1,93	1,508	9
Glass	1,74	1,137	10
Gas	1,55	1,121	11

Table 4.12 displays the ranking of the raw materials that are used in manufacturing the products that are sold. Liquid chemical had the highest ranking with a mean of 3.81 and a standard deviation of 1.377. The second highest was allocated to water, which had a mean of 3,31 and a standard deviation of 1,346. Powder chemical had a third ranking with a mean of 3,05 and standard deviation of 1,558. Paper was ranked fourth with a mean of 2,94 and a standard deviation of 1,324.

This was followed by plastic with a mean of 2,81 and a standard deviation of 1,513. Rubber was ranked number 6, with a mean of 2,68 and a standard deviation of 1,433. Boxes were ranked number 7 in terms of raw materials used, it was allocated a mean of 2,01 and standard deviation of 1,504. Fabric and Wood both had a mean of 1,93, and were both ranked at number 9, fabric had however a standard deviation of 1,520 and wood 1,508. Glass and Gas were the lowest ranked items, Glass was ranked number 10 and Gas at number 11. Glass had a mean of 1,74 and a standard deviation of 1,137, whereas Gas had a mean of 1.55 and a standard deviation of 1,121.

These results mean that the most used raw materials where liquid chemical, water powder chemical, paper and plastics. Moderately used raw materials were rubber, steel, boxes and fabric. The least used raw materials were wood, glass and gas.

4.3.2 **Exploratory Factor Analysis on waste produced in Industrial Parks.**

The table 4.13 below indicates the relationship between items relating to the waste produced in Industrial Parks in Soweto

Table 4. 13 Correlation Matrix for the Waste Produced in the Industrial Parks.

Correlation Matrix												
		Rubber	Plastic	Steel	Paper	Glass	Boxes	Fabric	Gas	Water	Liquid Chemical	Powder Chemical
Correlation	Rubber	1,000	0,043	0,266	0,098	0,259	0,120	0,230	0,378	0,017	0,092	0,157
	Plastic	0,043	1,000	0,314	0,427	0,128	0,345	0,077	0,042	0,000	0,105	0,093
	Steel	0,266	0,314	1,000	0,226	0,000	0,219	0,099	0,368	0,111	0,128	0,026
	Paper	0,098	0,427	0,226	1,000	0,113	0,375	0,011	0,074	0,040	0,098	0,151
	Glass	0,259	0,128	0,000	0,113	1,000	0,257	0,210	0,019	0,011	0,148	0,198
	Boxes	0,120	0,345	0,219	0,375	0,257	1,000	0,037	0,027	0,032	0,185	0,012
	Fabric	0,230	0,077	0,099	0,011	0,210	0,037	1,000	0,128	0,092	0,110	0,121
	Gas	0,378	0,042	0,368	0,074	0,019	0,027	0,128	1,000	0,149	0,140	0,115
	Water	0,017	0,000	0,111	0,040	0,011	0,032	0,092	0,149	1,000	0,430	0,433
	Liquid Chemical	0,092	0,105	0,128	0,098	0,148	0,185	0,110	0,140	0,430	1,000	0,602
	Powder Chemical	0,157	0,093	0,026	0,151	0,198	0,012	0,121	0,115	0,433	0,602	1,000

The Correlations indicated coefficients higher than 0.3. This means that the strength of the inter-correlations between the items is high, and it is therefore acceptable.

When the Cronbach alpha value is below 0.7, then the relationship between the items is viewed as unreliable and not valid, Table 4.14. The Cronbach alpha seeks to validate the relationships between the items that are used to develop factors.

Table 4.14 Cronbach's Alpha

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha based on standardized Items	No of Items
0,741	0,744	9

The Cronbach alpha for the waste materials items was found to be above 0.7. This means that the items are valid and reliable and can further be used to develop factors. The study found the Cronbach alpha value of 0.74.

Table 4.15 indicates the KMO measure of sampling adequacy and the Bartlett's Test.

Table 4. 15 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,624
Bartlett's Test of Sphericity	Approx. Chi-Square	284,085
	df	55
	Significance	0,000

The KMO value was found to be 0.624. and the acceptable value is 0.6. This means that the value found is acceptable for the study. The acceptable value for the Bartlett's Test of Sphericity is below 0.5, the study found the value of significance to be 0.00, which is deemed acceptable.

Figure 4.16 displays the Eigenvalue which is set at 1.0. this means that only the factors above the 1.0 value will be considered.

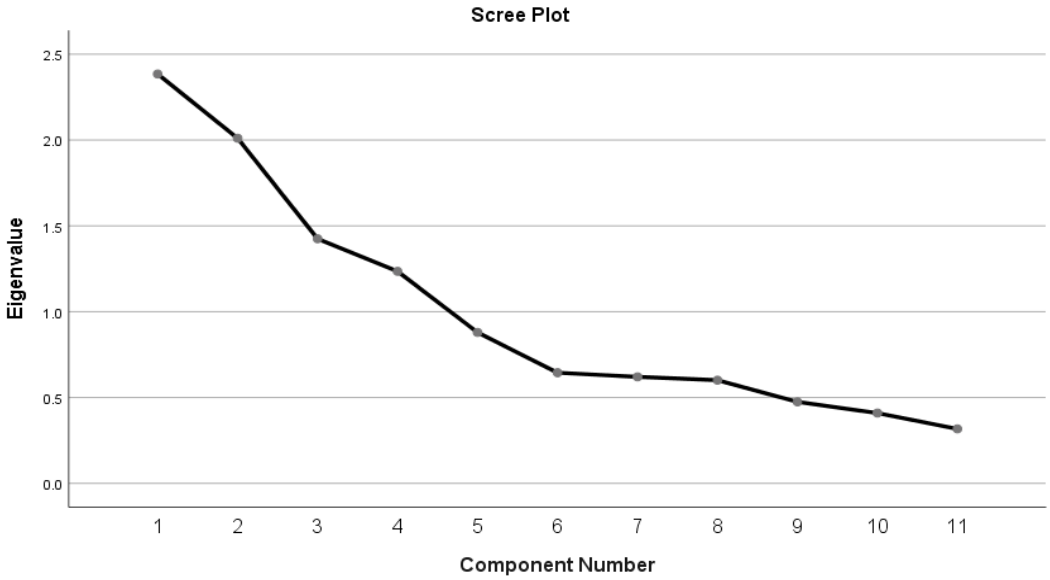

Figure 4.16 Screen Plot Eigenvalue

Four factors identified above the eigenvalue of 1.0. This means that there are four factors identified that will be used to classify the waste produced by the Industrial Parks in Soweto. These factors are classified in Table 4.16, through the pattern matrix.

Table 4. 16 Pattern Matrix

Pattern Matrix[a]				
	Component			
	1	2	3	4
Liquid Chemical	0,835			
Powder Chemical	0,805			
Water	0,780			
Paper		0,778		
Plastic		0,738		
Boxes		0,724		
Gas			0,838	
Steel			0,710	
Rubber			0,620	
Glass				0,722
Fabric				0,714
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.				

The pattern matrix, Table 4.16, classified the four factors as identified in the screen plot in Figure 4.16. These factors are classified based on their likeness to each other through the principal component analysis.

Each factor that was extracted had a percentage of variance attached to it, as indicated in Table 4.17.

Table 4. 17 Total Variance Explained

Total Variance Explained							
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2,385	21,679	21,679	2,385	21,679	21,679	2,046
2	2,011	18,278	39,957	2,011	18,278	39,957	2,030
3	1,425	12,950	52,907	1,425	12,950	52,907	1,705
4	1,235	11,226	64,133	1,235	11,226	64,133	1,507
5	0,879	7,993	72,126				
6	0,644	5,858	77,983				
7	0,620	5,637	83,621				
8	0,601	5,463	89,084				
9	0,474	4,313	93,397				
10	0,409	3,721	97,118				
11	0,317	2,882	100,000				
Extraction Method: Principal Component Analysis.							

Factor 1 had a percentage of variance of 21.68%, factor 2 had a percentage of variance of 18.29%, factor 3 was 12.95% and factor 4 had a percentage of variance of 11.23%. the cumulative percentage for all the factors was approximately 64%. This means that a majority of the sample was considered in deriving the factors.

Factor 1: *Chemical water*

Factor 1 was named chemical water. This factor was made up of three principles, Liquid chemical (83.5%), Powder Chemical (80.5%) and Water (78.0%). These elements were based on the pattern matrix in Table 4.16. The percentage of variance for the factor is 21.68%, this is based on Table 4.17.

Factor 2: *Primary Waste*

Factor 2 was assigned 3 principles. The following principles were used Paper (77,8%), Plastic (73,8%) and (72,4%) as indicated in table 4.16. This factor was named primary waste. The percentage of variance for the factor was 18,28% as stated in table 4.17.

Factor 3: *Energy and Metal*

Factor 3 was named energy and metal. The principles that concluded this factor are the following; Gas (83,8%), Steel (71,0%) and Rubber (62,0%). The percentage of variance for this factor was 12,95%, this value was found in table 4.17 which reflects the total variance through principal component analysis.

Factor 4: *Secondary Waste*

Factor 4 was based on 2 elements, named Glass (72,2%) and Fabric (71,4%). This factor was named secondary waste, and based on table 4.17, it had a percentage of variance of 11.23%.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach Alpha if Deleted
Reducing waste	27,26	36,181	0,428	0,357	0,717
Waste removal	26,68	37,346	0,485	0,401	0,707
Waste treatment	27,11	38,973	0,336	0,292	0,731
Recycling waste	26,85	37,712	0,482	0,328	0,708
Reusing waste	26,80	36,990	0,513	0,444	0,702
Recovering Waste	27,15	37,193	0,452	0,397	0,712

Storage of waste (before disposal or removal)	26,93	38,759	0,356	0,324	0,728
Education and training (on how to deal with different types of waste)	27,30	38,434	0,417	0,444	0,718
Selling waste to other businesses	27,26	39,322	0,309	0,377	0,736

Table 4. 18 Ranking of Waste produced

Descriptive Statistics			
Item	Mean	Std. Deviation	Ranking (R)
Liquid Chemical	3,14	1,417	1
Water	2,79	1,282	2
Paper	2,47	1,315	3
Powder Chemical	2,47	1,461	3
Plastic	2,47	1,451	3
Steel	2,29	1,612	4
Rubber	2,25	1,378	5
Boxes	1,82	1,320	6
Fabric	1,72	1,372	7

Glass	1,46	0,881	8
Gas	1,29	0,754	9

Based on the rankings of items that are prevalent in waste produced, as reflected in Table 4.18, it was found that liquid chemical is the most produced waste. It had the mean of 3,14 and a standard deviation of 1,417. The second ranking was allocated to water, with a mean of 2,79 and standard deviation of 1,282. Paper, Powder chemical and plastic, all had the third raking as they all had a mean value of 2,47, paper had a standard deviation of 1,315, powder chemical 1,461 and plastic 1,451.

Steel was allocated a mean value of 2,29 and a standard deviation 1,612, it was ranked at number 4 in terms of waste produced. Rubber was ranked number with a mean value of 2,25 and a standard deviation value of 1,378. It was followed by boxes, which were ranked number 6 and had a mean of 1,82 and a standard deviation of 1,320. Fabric, Glass, and Gas had the lowest rankings in terms of waste produced. Fabric had a mean of 1,72, and a standard deviation of 1,372, Glass had a mean of 1,46 and a standard deviation of 0.881, whereas Gas had a mean of 1,29 and a standard deviation of 0,754.

These results mean that the most produced waste were Liquid Chemical, Water, Paper, Powder Chemical and Plastic. Moderately produced waste materials were steel, rubber and boxes, whereas the least produced waste materials were fabric, glass and gas.

4.3.3 Exploratory Factor Analysis on challenges on waste management

There were several challenges identified in managing waste from the Industrial Parks, as seen in Table 4.19. These challenges were analysed through correlation matrix and pattern matrix to create factors that will differentiate between the main challenges and least challenges in managing waste at the industrial park.

Table 4. 19 Challenges of waste management

Item
Reducing waste
Waste removal
Waste treatment
Reusing waste

Recovering Waste
Storage of waste (before disposal or removal)
Education and training (on how to deal with different types of waste)
Selling waste to other businesses

The challenges identified include the following; Reducing waste, Waste removal, Waste treatment, Reusing waste, Recovering waste, Storage of waste (before disposal or removal), Education and training (on how to deal with different types of waste) and Selling waste to other businesses.

Table 4.20 below shows the correlation matrix on waste management challenges.

The correlation value is required to be above 0.3 to indicate the strength of the relationships amongst the variances, see Table 4.20.

Table 4. 20 Correlation Matrix on waste management challenges.

Correlation Matrix									
		Reducing waste	Waste removal	Waste treatment	Reusing waste	Recovering Waste	Storage of waste (before disposal or removal)	Education and training (on how to deal with different types of waste)	Selling waste to other businesses
Correlation	Reducing waste	1,000	0,489	0,388	0,307	0,105	0,034	0,145	0,118
	Waste removal	0,489	1,000	0,427	0,218	0,156	0,301	0,147	0,023
	Waste treatment	0,388	0,427	1,000	0,270	0,155	0,062	0,039	0,113
	Reusing waste	0,307	0,218	0,270	1,000	0,573	0,118	0,184	0,199
	Recovering Waste	0,105	0,156	0,155	0,573	1,000	0,272	0,269	0,279
	Storage of waste (before disposal or removal)	0,034	0,301	0,062	0,118	0,272	1,000	0,460	0,254
	Education and training (on how to deal with different types of waste)	0,145	0,147	0,039	0,184	0,269	0,460	1,000	0,555

	Selling waste to other businesses	0,118	0,023	0,113	0,199	0,279	0,254	0,555	1,000

The correlation values are indicated as above 0.3 for all the components displayed in table 4.20. This means that there is a strong relationship between the items that have been identified as challenges of the waste management.

The study used the Cronbach Alpha to assess the validity of the items used in assessing the challenges related to waste management at the Soweto Industrial Parks (See Table 4.21. below)

Table 4. 21 Cronbach's Alpha

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0,729	0,723	10

The Cronbach Alpha value was found to be 0.73. This means that there is a strong relationship between the items used to assess the challenges of waste management; the value also means that the items are valid and reliable and can be used further to derive factors.

The KMO value is acceptable when it is above 0.6, and the Bartlett's test is sufficient when it is found to be below 0.4. See Table 4.22 below.

Table 4. 22 KMO and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,642
Bartlett's Test of Sphericity	Approx. Chi-Square	263,491
	df	28
	Significance.	0,000

The KMO value was found to be 0.642, this means that it can be accepted. The Bartlett's test valued a significance of 0.000 which is also an acceptable value for this study.

The screen plot on Figure 4.17 below, indicates the eigenvalue that is put at the value of 1.0,

and the number of factors that can be established.

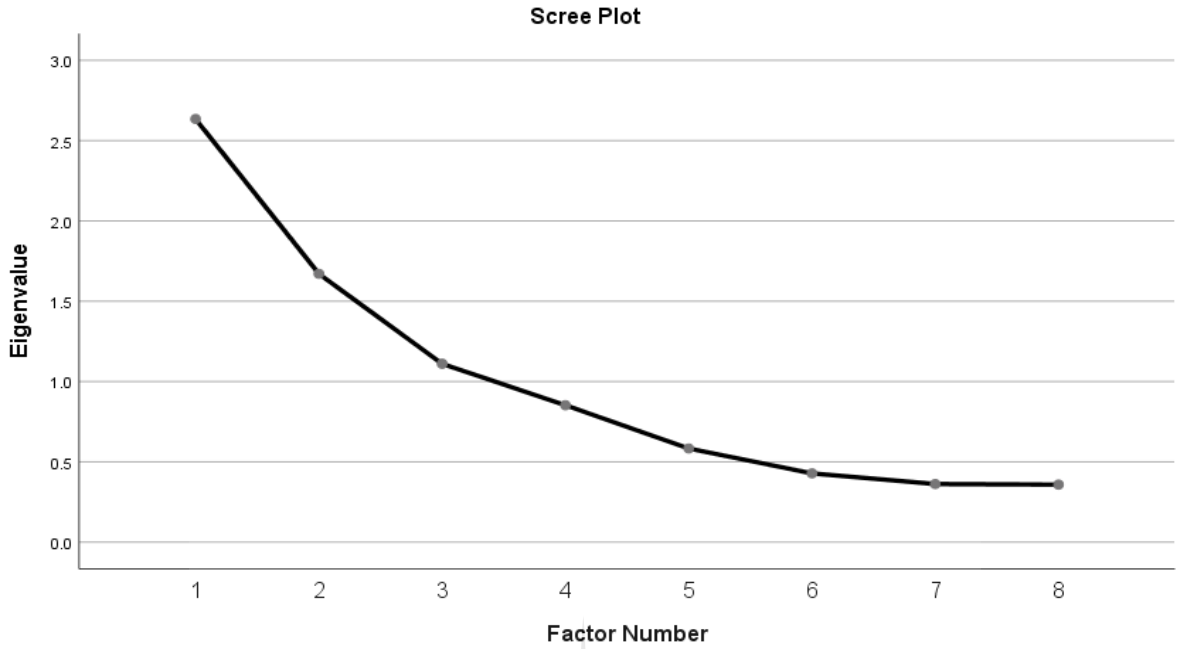

Figure 4.17 Screen Plot Eigenvalue.

Three eigenvalues were above 1.0. This means that there are three factors that are established about the challenges of waste management, and this is indicated in Figures 4.17.

Table 4. 23 Rotated Factor matrix.

Rotated Factor Matrix			
	Factor		
	1	2	3
Education and training (on how to deal with different types of waste)	0,853		
Selling waste to other businesses	0,606		
Storage of waste (before disposal or removal)	0,508		
Waste removal		0,797	
Waste treatment		0,582	
Reducing waste		0,582	
Reusing waste			0,858
Recovering Waste			0,605
Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.			

The list of variables that constitute the three factors identified in Figure 4.17 are elaborated on in Table 4.23, which used the principal axis factoring to conclude the alignment of these factors.

The total variance table 4.24, displays the percentage of variance for each factor that was established and the cumulative percentage for all the factors in relation to the total sample that was used in the study.

Table 4. 24 Total Variance Explained.

Total Variance Explained									
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Vari-ance	Cumula-tive %	Total	% of Vari-ance	Cumul-ative %	Total	% of Vari-ance	Cumulat ive %
1	2,635	32,934	32,934	2,192	27,398	27,398	1,478	18,479	18,479
2	1,671	20,887	53,821	1,174	14,677	42,076	1,424	17,805	36,283
3	1,110	13,881	67,702	0,742	9,279	51,355	1,206	15,072	51,355
4	0,853	10,657	78,360						
5	0,583	7,291	85,651						
6	0,428	5,351	91,002						
7	0,362	4,521	95,523						
8	0,358	4,477	100,000						

Factor 1 had a percentage of variance of 32.93%, Factor 2 had a percentage of 20.89% and Factor 3 had a percentage of variance of 13.88%. The cumulative percentage for the factors was 51.26%. This is large enough to make recommendations and conclusions on the identified factors.

- Factor 1: *Training and Business Operations*

Factor 1 was named Training and Business Operations. This factor was comprised three principles named, Education and Training (85,3%), Selling waste to other businesses (60,6%) and Storage of waste (50,8%), and these figures can be found in Table 4.23 The percentage of variance for this factor 32.93%, this is seen in Table 4.24.

- Factor 2: *Waste Organisation*

The principles that make up Factor 2 are Waste (79,7%), Waste treatment (58,2%) and Reducing waste (58,2%). The factor was named Waste organisation. The percentage of variance for the factor was found to be 20,89%, as seen in Table 4.24.

- Factor 3: *Waste Recovery*

Factor 3 was named Waste recovery. This Factor comprises 2 factors, namely Reusing waste (85,8%) and Recovering waste (60,5%), as indicated in Table 4.23. This factor was allocated 67,70% as a percentage of variance, as illustrated in Table 4.24.

Table 4. 25 Ranking of challenges on waste management

Descriptive Statistics			
	Mean	Std. Deviation	Ranking
Waste removal	3,72	1,286	1
Reusing waste	3,60	1,255	2
Recycling waste	3,55	1,217	3
Storage of waste (before disposal or removal)	3,49	1,330	4
Waste treatment	3,32	1,342	5
Recovering Waste	3,28	1,343	6
Reducing waste	3,14	1,540	7
Education and training (on how to deal with different types of waste)	3,14	1,241	7
Selling waste to other businesses	3,14	1,360	7
Waste Incineration	2,22	1,459	8

A total of eight rankings were identified and allocated to a total of 10 variables, in Table 4.25. Waste removal had the highest ranking in terms of challenges, and this variable had a mean of 3,72 and a standard deviation of 1,286. The second ranking was allocated to Reusing waste with a mean of 3,60 and a standard deviation of 1,254. Recycling had a mean of 3,55 and a standard deviation of 1,217. The fourth ranking was attached to Storage of waste, with a mean of 3,49 and a standard deviation of 1,330. Waste treatment had a mean of 3,32 and standard deviation of 1,343 and was ranked at number 4. Recovering waste was ranked at number 6, with a mean of 3,28 and a standard deviation of 1,343. Reducing waste, education and training on how to deal with the different types of waste and selling waste to other businesses were ranked at number 8 as they all had a mean value of 3,14.

Reducing waste had a standard deviation value of 1,540, education and training had a standard deviation of 1,241 whereas selling waste had a standard deviation of 1,360. Waste incineration was ranked number 8 as it had a mean of 2,22 and a standard deviation of 1,459

These values mean that the Industrial Parks' biggest challenges in waste management where concerned with; Waste removal, Reusing waste, Recycling waste, Storage of waste (before disposal or removal) and Waste treatment. Minor challenges are also faced in relation in relation to the Recovering Waste, Reducing waste, Education and training (on how to deal with different types of waste), Selling waste to other businesses and Waste Incineration.

4.3.4 Exploratory Factor Analysis on possible waste reduction techniques in Soweto Industrial Parks

The correlation matrix, Table 4.26, is normally accepted at the value of above 0.3.

Table 4. 26 Correlation Matrix on waste reduction techniques

Correlation Matrix											
		Recycle	Reuse	Recover	Open Burning	Incineration	Make Compost	Bury	Dump waste	Obtain training on how to reduce waste	Sell waste to other businesses or individuals
Correlation	Recycle	1,000	0,452	0,432	0,075	0,188	0,174	0,188	0,078	0,041	0,275
	Reuse	0,452	1,000	0,553	0,020	0,014	0,010	0,048	0,096	0,027	0,168
	Recover	0,432	0,553	1,000	0,150	0,039	0,035	0,054	0,145	0,142	0,032
	Open Burning	0,075	0,020	0,150	1,000	0,307	0,293	0,269	0,204	0,046	0,033
	Incineration	0,188	0,014	0,039	0,307	1,000	0,504	0,361	0,039	0,011	0,062
	Make Compost	0,174	0,010	0,035	0,293	0,504	1,000	0,479	0,213	0,159	0,111
	Bury	0,188	0,048	0,054	0,269	0,361	0,479	1,000	0,377	0,152	0,058
	Dump waste	0,078	0,096	0,145	0,204	0,039	0,213	0,377	1,000	0,336	0,260
	Obtain training on how to reduce waste	0,041	0,027	0,142	0,046	0,011	0,159	0,152	0,336	1,000	0,375
	Sell waste to other businesses or individuals	0,275	0,168	0,032	0,033	0,062	0,111	0,058	0,260	0,375	1,000

The study found the correlation matrix for all the variables to be above 0.3. This means that there is a strong relationship amongst the variables which is what is required to validate the variables identified.

The Cronbach alpha was used to find out if the items used to classify the waste management techniques were valid and reliable; see Table 4.27 below. When the items are deemed reliable, this means that the study can accept them as they are.

Table 4. 27 Cronbach's Alpha

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,741	0,744	9

Given that the Cronbach Alpha value is above 0.7, the items used to classify the waste management techniques are deemed as valid and reliable. This means that the factors that are derived from these items would also be valid, reliable and acceptable in the study.

The KMO measure of sampling adequacy is acceptable when it is above 0.6, whereas the Bartlett's test of Sphericity is acceptable, is acceptable when the significance value is below 0.5, table 4.28.

Table 4. 28 KMO and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,602
Bartlett's Test of Sphericity	Approx. Chi-Square	290,573
	df	45
	Significance	0,000

The study found the KMO measure of sampling adequacy to be 0.602, so this value can be accepted by the study as it is above the required value of 0.6. The Bartlett's test was found to have a significance of 0.000, this can also be acceptable as it is below 0.4.

The screen plot (See Figure 4.18 below), displays the eigenvalues and signifies the number

of factors that can be classified in relation to potential waste reduction techniques.

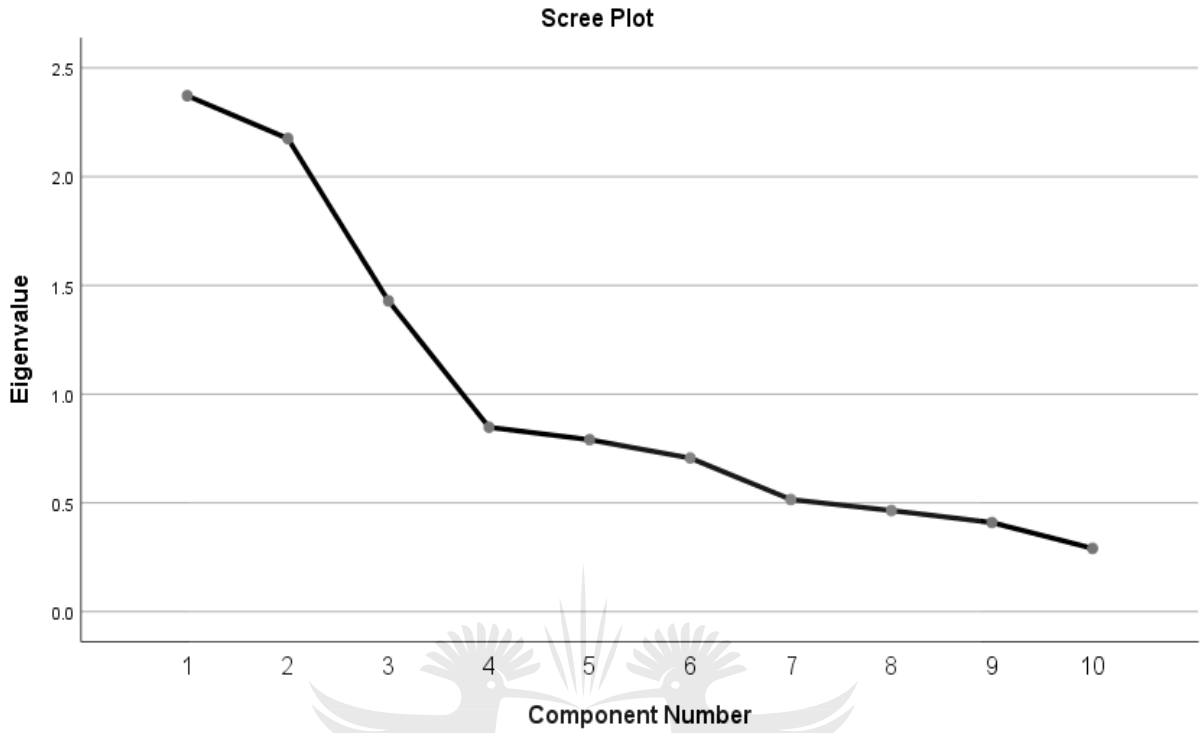

Figure 4.18 Scree Plot Eigenvalue

It was found that there were three factors that are above the value of 1.0. which means that in potential waste management techniques there are only three factors that can be considered, as illustrated in Figure 4.18 and Table 4.29.

The pattern matrix displays the pattern of the factors based on the eigenvalues identified in Figure 4.18. The considered factors are those with the eigenvalues of above 1.0.

The principal component analysis method was used to classify the variables for each factor based on their close relation with each other, as shown in Table 4.29 below.

Table 4. 29 Pattern Matrix

Pattern Matrix			
	Component		
	1	2	3
Make Compost	0,796		
Incineration	0,750		
Bury	0,672		
Open Burning	0,618		
Reuse		0,842	
Recover		0,834	
Recycle		0,718	
Obtain training on how to reduce waste			0,785
Sell waste to other businesses or individuals			0,734
Dump waste			0,652
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.[a]			

Total variance explained can be seen in Table 4.30 below.

Table 4. 30 Total Variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2,372	23,719	23,719	2,372	23,719	23,719	2,278
2	2,175	21,753	45,472	2,175	21,753	45,472	2,041
3	1,429	14,288	59,76	1,429	14,288	59,760	1,788
4	0,848	8,475	68,235				
5	0,790	7,903	76,139				
6	0,706	7,062	83,2				
7	0,515	5,155	88,355				
8	0,465	4,645	93,0				
9	0,409	4,093	97,093				
10	0,291	2,907	100				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Each factor that was identified had a percentage of variance allocated to it. Factor 1 had a percentage of variance of 23.71%, Factor 2 had a percentage of variance of 21.75% and Factor 3 was allocated a percentage of variance of 12.29%. The cumulative percentage for all the factors was 59.76%, which means that 59.76% of the entire study sample was considered in deriving these factors. This value can be accepted for the study.

- Factor 1: *Manure and sweltering*

Factor 1 was named manure and sweltering. This factor is made up four principles namely; make compost (79,6%), incineration (75,0%), bury (67,2%) and open burning (61,8%). The percentage of variance for this factor was 23,72%, this value is illustrated in Table 4.30.

- Factor 2: *Recycling*

This factor comprises of three principles, namely; Reuse (84,2%), Recover (83,4%) and Recycle (71,8%). These values can be found in Table 4.29 above. This factor was named recycling. The recycling factor had a percentage of variance, as illustrated in Table 4.30, of 21.75%.

- Factor 3: *Training and reduction.*

This factor was named training and reduction. It is made up of 3 principles named; Obtain training on how to reduce waste (78.5%), sell waste to other businesses or individuals (73,4%) and dump waste (65,2%), as illustrated in Table 4.30 above. The percentage of variance for this factor was allocated as 14.29%.

Table 4. 31 Ranking of waste reduction techniques

Descriptive statistics			
	Mean	Standard Deviation	Ranking
Dump waste	3,04	1,304	1
Make Compost	2,98	1,250	2
Incineration	2,93	1,525	3
Bury	2,91	1,234	4
Obtain training on how to reduce waste	2,65	1,218	5
Open burning	2,51	1,373	6
Sell waste to other businesses or individuals	2,36	1,185	7
Recover	2,06	1,045	8
Reuse	1,83	0,876	9
Recycle	1,50	0,727	10

There were several initiatives that were identified to reduce the waste produced as can be seen in Table 4.31. The Industrial Parks indicated dumping waste as the best way to reduce waste produce. This variable had the highest mean value of 3,04 and a standard deviation of 1,304. Making compost using the waste produced was also identified as an option in waste reduction techniques. This variable was ranked second and had a mean of 2,98 and a standard deviation of 1,250.

The third ranking was identified as incineration of waste, with a mean value of 2,93 and a standard deviation of 1,524. The fourth ranking was allocated to burying waste, with a mean value of 2,91 and a standard deviation of 1,234. The fifth variable with a mean of 2,65 and a standard deviation of 1,218 was obtaining training on how to reduce waste. Open burning was ranked at number 6 with a mean value of 2,51 and a standard deviation of 1,373. Selling waste to other businesses or individuals was ranked at number 7, as this variable had a mean value of 2,36 and a standard deviation of 1,184. This was followed by open burning with a mean of recovering waste which had a mean value of 2,06 and a standard deviation 1,044. The lowest rankings were allocated to reusing waste and recycling waste, reusing waste had a mean value of 1,83 and a standard deviation of 0,876 whereas recycling waste had a mean of 1,50 and a standard deviation of 0,727.

These values indicate that the most favourable techniques to reduce waste within the Industrial Parks were Dumping waste, Making compost, Incineration of waste, Burying waste and Obtaining training on how to reduce waste. The least favourable techniques were Open burning of waste, Selling waste to other businesses or individuals, Recovering waste, Reusing waste, and Recycling waste.

4.4 Conclusion

This chapter analysed the raw materials that the Industrial Parks in Soweto use. The chapter also analysed the waste that is produced in the Industrial Parks. It was found that that the Industrial Parks have challenges in waste management and are not informed in terms of waste management techniques that are available for them. It was also found that the businesses in the industrial park are keen on selling waste, and some on buying waste from other businesses in the industrial park network. The factors identified were found to be valid and acceptable, this means that these factors can be used to design an Eco-industrial park framework.

It can therefore be concluded that there are environmental impacts caused by Industrial Parks based on the raw materials and waste produced. It can further be concluded that the development of an Eco-industrial park framework for Soweto is necessary and can be validated by the presence of the environmental impacts. Lastly, the study can conclude that there is an appetite for Eco-Industrial Parks in Soweto based on the businesses' keenness to buy and sell their waste for the production of their products at lower prices within the Industrial Parks business network.

5. DISCUSSION

5.1 Introduction

This chapter discusses how the results meet the objectives and sub-objectives of the study. The chapter addresses each objective and provides meaning of the results obtained, further aligning it to the holistic meaning for the study. The study's main objective was to develop a framework that will assist in the development of Eco-industrial parks in Soweto that will ultimately enable businesses to apply the concept of cleaner production. This objective was divided into five sub-objectives, which are as follows:

1. To evaluate the current environmental impacts of Industrial Parks in Soweto.
2. To assess current environmental framework through literature review
3. To test appetite for Eco-industrial parks in Soweto
4. To develop a novel Eco-industrial park framework for Soweto
5. To assess potential benefits of developing eco industrial parks in Soweto

The results of the study, as stated in chapter 4, addresses these objectives and provides details that clarify the sub-objectives.

5.2 Sub-Objective 1: To evaluate the current environmental impacts of Industrial Parks in Soweto

The study found that the Industrial Parks in Soweto reported that the raw materials that are being used are similar to the waste that is being produced, this is indicated in table 5.1 and 5.2 below.

Table 5. 1 Raw materials

Item	Mean ($\bar{x}$)	Standard Deviation (σX)	Ranking (R)
Liquid Chemical	3,81	1,377	1
Water	3,31	1,346	2
Powder Chemical	3,05	1,558	3
Paper	2,94	1,325	4
Plastic	2,81	1,513	5
Rubber	2,68	1,433	6
Steel	2,54	1,621	7
Boxes	2,01	1,504	8
Fabric	1,93	1,520	9
Wood	1,93	1,508	9
Glass	1,74	1,137	10
Gas	1,55	1,121	11

Table 5. 2 Waste produced

Item	Mean	Std. Deviation	Ranking (R)
Liquid Chemical	3,14	1,417	1
Water	2,79	1,282	2
Paper	2,47	1,315	3
Powder Chemical	2,47	1,461	3
Plastic	2,47	1,451	3
Steel	2,29	1,612	4
Rubber	2,25	1,378	5
Boxes	1,82	1,320	6
Fabric	1,72	1,372	7

Glass	1,46	0,881	8
Gas	1,29	0,754	9

The environmental impacts of each were then analysed.

5.2.1 Environmental impact of liquid chemicals and wastewater on the environment

Liquid chemicals are substances which when they are breathed in, ingested or if they enter the skin, may include deferred or constant impacts that include cancer (Devillers 2003). When liquid chemicals are discharged into the environment or on water streams, they can present detrimental effects which can be long term. It was found that prolonged human exposure to liquid chemicals may also lead to leukaemia, (Devillers ,2003).

5.2.2 Environmental Impact of plastic

Plastic is manufactured using poisonous composites which can cause sicknesses as it does not decompose. Plastic causes the following harm to the environment and the human population (UNEP 2013):

5.2.2.1 *Groundwater Pollution*

The global water has been in increasing danger from permeable waste and plastics. Groundwater and reservoirs are vulnerable to ecological pollutants. Most of the pollutants that affect the oceans are made up of plastics. This has negative effect on the marine species and thus has a negative effect on humans who routinely eat fish.

5.2.2.2 *Terrestrial Pollution*

The dumping of plastic into landfills allows it to come into contact with water which then creates dangerous chemicals. These chemicals are absorbed underground and thus damage the quality of water. Parts of plastics are carried by wind which increases the clutter on land. Plastic can also get trapped on trees, towers, traffic lights and poles which increases the risk of animal and human suffocation.

5.2.2.3 *Air Pollution*

When plastic is burnt in the open, it increases ecological pollution as it discharges dangerous chemicals. When these chemicals are breathed in by humans and animals, they can cause respirational issues.

5.2.3 Environmental Impact of Paper (Hess, 2017)

5.2.3.1 *Air Pollution*

The industries that produce paper have a large effect of environmental pollution as they use chemicals that are main factors in acid rain and responsible for climate change, as they are greenhouse gases.

5.2.3.2 *Water Pollution*

Paper mills contain agents such as alcohol and inorganic resources as chlorate. When these chemicals are discharged into the lakes, rivers and oceans, they will damage and pollute these environments.

5.2.3.3 *Paper Waste*

Approximately 26% of waste that is discarded is paper. The paper industry produces paper using a lot more water than other industries. The de-inking process of ink from paper during the recycling process also releases harmful chemicals into the environment.

5.2.4 Environmental impacts of powder chemicals (Sheppard, 2011)

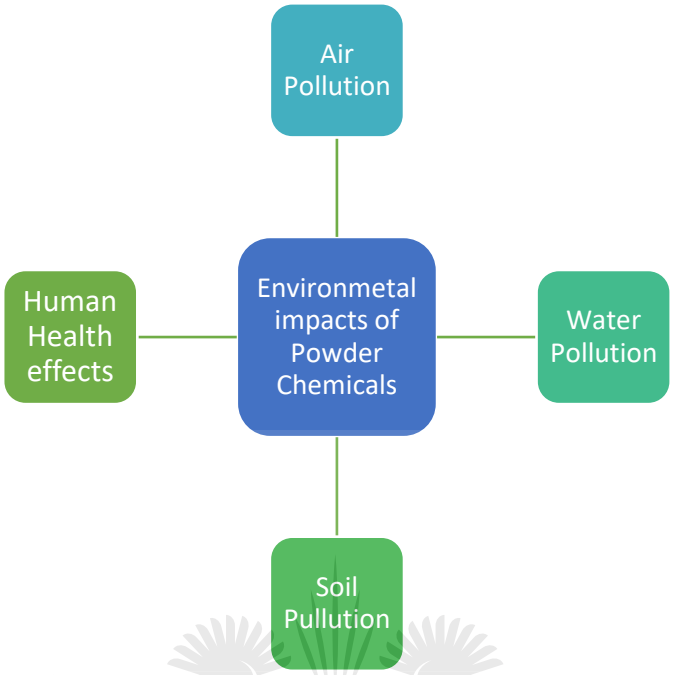

Figure 5.1 Environmental impacts of powder chemicals. Sheppard (2011).

5.2.4.1 *Water Pollution*

Chemical industries discharge many pollutants into the environment which have dire effects for the water bodies. When this discharge occurs into the water streams it results in water pollution. Water streams are polluted by dangerous chemicals and thus the discharge of wastewater into water streams negatively affects the human health, marine life and the environment.

5.2.4.2 *Air Pollution*

The increase in greenhouse gases have been associated with the increase in manufacturing factories, both small and large. The emissions from manufacturing factories include sulphur, carbon dioxide, methane and nitrogen.

When these emissions are released in large quantities into the environment, they have a negative impact of human health in terms of respiration, and become an environmental threat.

5.2.4.3 *Soil Pollution*

Industrial sites and parks dispose of waste into landfills, which contribute to soil pollution. When soil levels of richness and structure is lost due to human interaction, soil pollution occurs. Waste from Industrial Parks may contain harmful chemicals that when discharged into the landfills, gathers and degrades the quality of the soil and its nutrients and thus causing soil pollution, which may lead to soil poisoning.

5.2.4.4 *Effect on Human Health*

It was indicated by (UNEP 2015) That 2% of the world lung diseases is caused by outdoor air pollution. Furthermore, 5% of the world's lung cancers and 1% of the world's chest pains are the caused by outdoor air pollution. These values indicate that air pollution decreases the levels of human health. The industrial waste that is discharged into the landfills and in the form of wastewater also contribute to air pollution which negatively affect humans.

5.3 Sub-Objective 3: To test appetite for Eco-industrial parks in Soweto

To test for appetite for the development of Eco-industrial parks in Soweto, the researcher investigated whether the current Industrial Parks perceived any benefits from the development of an Eco-industrial park.

This investigation involved finding out whether the businesses would be interested in buying and selling waste to each other within the park, with the aim of reducing waste produced and creating a greener business environment, which is the aim of an Eco-industrial park, as illustrated in Figures 5.2 and 5.3 below. The study further asked for views of where and Eco-industrial park might be located. See Figure 5.4. also below.

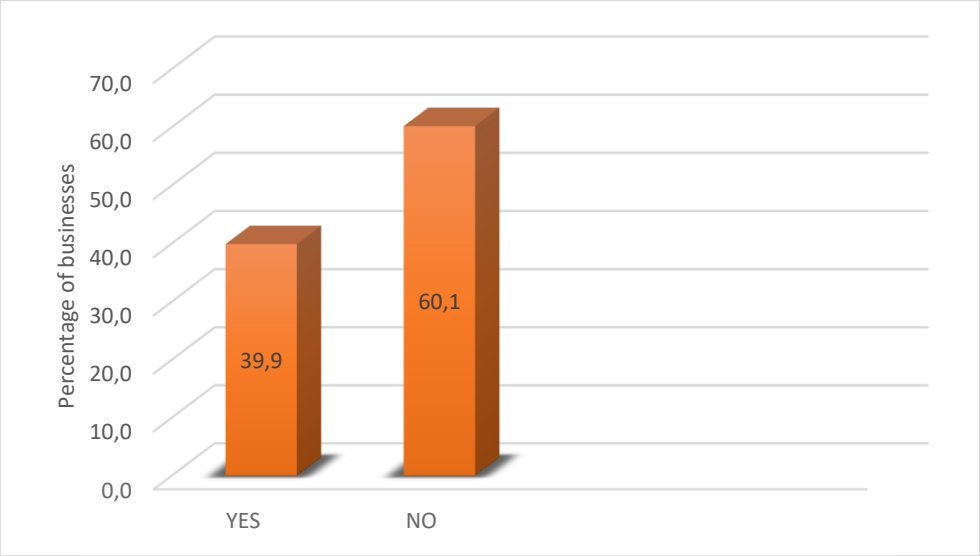

Figure 5.2 Perception on buying waste from other businesses in the Industrial Park

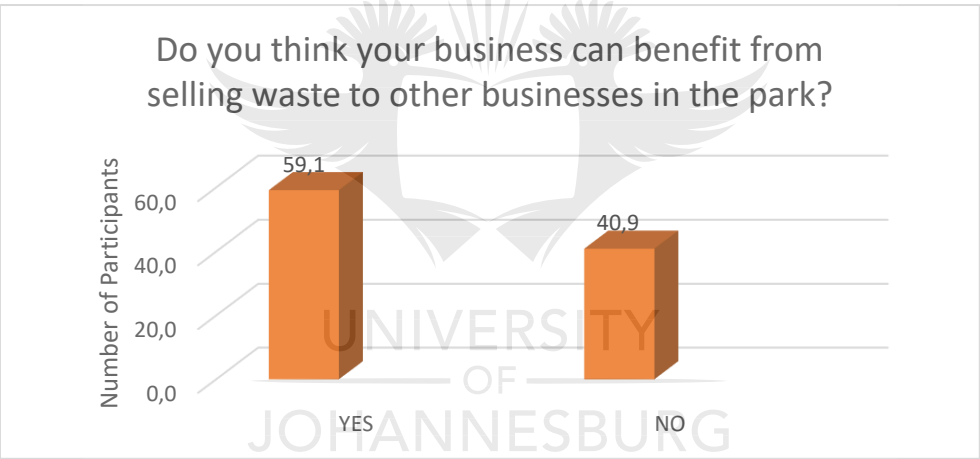

Figure 5.3 Perception on selling waste to other businesses in the Industrial Park

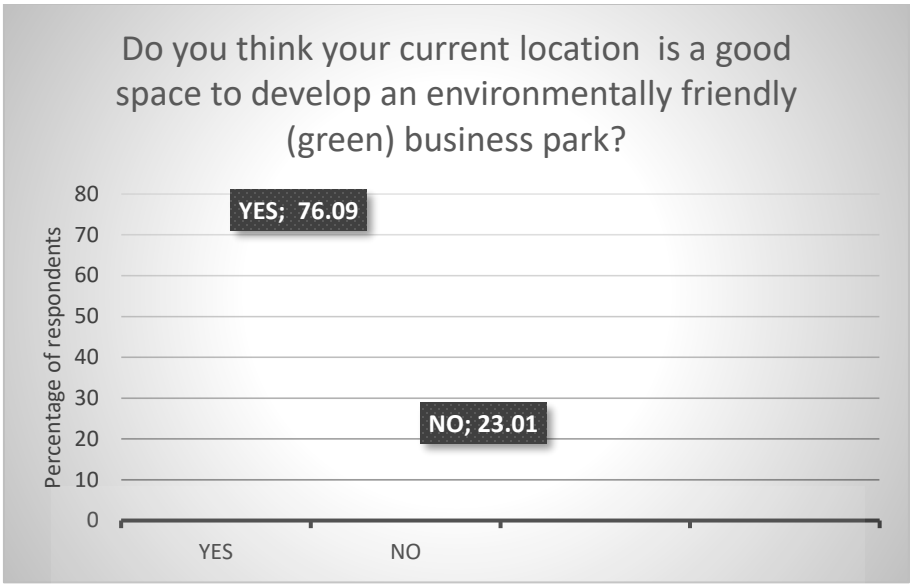

Figure 5.4 Eligibility of the location to develop an Eco-industrial park.

It was assessed that most businesses in the Industrial Parks are not keen on buying waste from other business within the park (Figure 5.2.) This may be due to their not being aware of what the other businesses produce as waste, and how it could be reused or recycled for environmental benefits. While the level of interest is low, it could be increased with education and exposure to waste management techniques.

Although many businesses indicated that they would be interested in selling their waste to other businesses (see Figure 5.3 above), they were still unaware of how that could be achieved. The researcher was however satisfied with the level of interest. This means that there is a satisfactory percentage of businesses within the Industrial Parks that are interested in the management of their waste in a way that will benefit the businesses and the environment, and therefore creating an Eco-industrial park.

The location of these parks was found to be favourable in terms of developing an Eco-industrial park (see Figure 5.4.above). This was judged through the perception of the business owners as they have greater knowledge of the business environment that they operate, which makes them the experts in that regard. All these factors combined showed that there is an appetite to develop an Eco-industrial park in Soweto, in the current locations of the Industrial Parks.

5.4 Sub-Objective 4: To develop a novel Eco-industrial park framework for Soweto

The proposed framework for the development of Eco-industrial parks in Soweto is discussed in Chapter 6. The framework is based on four principles namely; Organisational, Development, Sustainability and a Waste Monitoring and Control principle.

Each of these principles consists of factors and practices that, when applied, would add value to the development of Eco-industrial parks. The successful application of the Organisational principle leads to stakeholder support, whereas the successful application of the Development principle would lead to business innovation and development. Moreover, the successful application of the Sustainability principle would lead to efficient business training and learning, while the successful application of the Waste monitoring and Control principle would lead to effective waste administration and supervision. All these principles applied together should lead to the successful development of Eco-industrial parks.

5.5 Sub-Objective 5: To assess potential benefits of developing Eco industrial parks in Soweto

The potential benefits for developing an Eco-industrial park were assessed through the current businesses in the Industrial Parks. The study focused on how the businesses can benefit through selling and buying waste from other businesses in the Industrial Park (Tables 5.3. and 5.4 below).

This application will assist in the Industrial Parks in waste management and thus also developing an Eco-industrial park.

Table 5. 3 Benefits of buying waste.

How businesses can benefit from buying waste in the Industrial Parks.	Frequency	Percent
I buy empty bottles from households	1	0,7
I buy old couches and fix and resell them at a better price	1	0,7
I buy old metal and renew it	1	0,7
I buy old plastic products from domestic household transform and sell them	1	0,7
I buy old tyres	2	1,4
I buy old tyres to fix new ones	1	0,7
I buy old wood to make my crafts	1	0,7
I buy used wood	1	0,7
I buy wood from tree cutters to make my products	1	0,7
I can buy damaged crafts and renew them	1	0,7
I can buy old furniture and renew it for sale	1	0,7
I can buy old shoes to fix new shoes instead of buying new raw materials	1	0,7
I can buy old steel metal and renew it	1	0,7
I can buy rubber soles for cheaper prices	1	0,7
I can buy wood at a cheaper price	1	0,7
I can finance my raw materials	1	0,7
I can get the parts at a cheaper price	1	0,7
I can grow my business	1	0,7
I can have more plastics and papers to use for my herbs instead of buying them	1	0,7
I can open a scrap shop	1	0,7
I can save money in my raw materials	1	0,7
I can sell more products from the extra-raw materials	1	0,7
I can spend less on raw materials	1	0,7
I can use old fabric for new designs	1	0,7
I could have more raw materials on hand	1	0,7
I could use old material to train workers instead of new material that is expensive	1	0,7
I currently buy empty bottles and plastics	1	0,7

I use old metal to make new products	1	0,7
I will buy cheaper parts fix them and resell them	1	0,7
I would be able to access more metal	1	0,7

Table 5. 4 Benefits of selling waste.

How businesses can benefit from selling waste in the Industrial Parks.	Frequency	Percent
	77	55,4
By selling cans I make money for my business and get discount on my stock	1	0,7
I can be able to buy more machinery in my business	1	0,7
I can be able to order more stock for my stock	1	0,7
I can buy old car batteries and renew them	1	0,7
I can employ more people to assist with the workload	1	0,7
I can employ more workers during the festive season	1	0,7
I can finance other things I need in my store	1	0,7
I can generate more income in my business	1	0,7
I can get rid of the broken tiles at a price	1	0,7
I can have a new stream of income	1	0,7
I can hire more people to do the work	1	0,7
I can hire someone to sell the waste and pay them from it	1	0,7
I can make extra money for my business	1	0,7
I can make money from selling broken car parts	1	0,7
I can make money from the pieces don't use	1	0,7
I can make more money in my business	1	0,7
I can open a waste department	1	0,7
I can open a new waste department	1	0,7
I can reduce waste the waste I need to remove	1	0,7
I can remove the excess waste on my premises	1	0,7
I can sell leftover wood instead of burning it	1	0,7
I can sell my scrap metal parts and make additional money	1	0,7
I can sell my tyre pieces and make more money	1	0,7
I can sell my waste and clean up my premises	1	0,7
I can sell the leftover foam to the other upcoming business and create a collaboration with them	1	0,7
I can sell the scrap that I normally throw away	1	0,7
I can use any means of extra income in my business	1	0,7
I can use my waste as an income generator	1	0,7
I could sell them at a cheaper price and make money for my business	1	0,7

I exchange old parts for cash to buy new parts	1	0,7
I give away my waste it would be an advantage to sell it	1	0,7
I have damaged plastic bottles that are piling up space	1	0,7
I have fabric that I don't know what to do with that is left over from other products	1	0,7
I normally throw away left over material selling it would be a good substitute	1	0,7
I sell beer bottles and cans to make extra money	1	0,7
I sell broken car parts to the scrapyard	1	0,7
I sell cans and bottles that I collect from cars to pick-it up	1	0,7
I sell empty bottles to the bottle store	1	0,7
I sell plastic that cannot be re melted	1	0,7
I sometimes sell zinc leftovers to people in the camps to patch their roofs	1	0,7
I will be able to remove the containers in my premises by selling them	1	0,7
I would be able to grow my business	1	0,7
I would be able to buy secondhand car parts cheaper	1	0,7
I would be able to expand my operations	1	0,7
I would be able to remove some of the waste from my premises	1	0,7
I would be able to sell more things in my business	1	0,7
I would like to make more money in my business	1	0,7
I would sell instead of dumping it	1	0,7
Instead of storing and burning boxes I can sell them	1	0,7
Instead of storing it can sell it	1	0,7
It can generate more money in my business	1	0,7
It can help finance my new branch	1	0,7
It can help us deal with the high volume of glass waste produced	1	0,7
It would help the business financially in this current economic climate	1	0,7
It would reduce the attraction of thieves in my business	1	0,7
It would reduce the bad smell	1	0,7
It would reduce the waste that I have to store before removal	1	0,7
It would reduce the waste that is stored on my premises	1	0,7
Sometimes we don't know what to do with some of the waste selling it would help us keep our premises clean	1	0,7
We could hire more administration staff members	1	0,7
We have a lot of waste on the premises and it increases during municipal strikes I would appreciate any new initiative that would help me reduce it	1	0,7
We sell our waste to pawn shop	1	0,7

Total	**139**	**100,0**

Tables 5.3 and 5.4 above indicate that there are benefits to the development of Eco-industrial parks in Soweto. The businesses in Industrial Parks indicated a list of benefits for buying and selling waste in such parks, which are the basic principles of developing an Eco-industrial park. The concept of buying and selling waste to each other as businesses in the Industrial Park has shown the potential for financial gain for both buyer and seller.

Most businesses felt that they would be happy to buy the raw materials they need that are produced as waste by other businesses at a lower price, compared to buying from a supplier at a higher price. An increase in the buying of waste would promote the idea of an optimized business process in order to produce better products using second-hand raw materials, and moreover, also promote the concept of a green working environment. Businesses should focus on their main business as well as a secondary business.

The main idea of selling the waste that a business produces was aimed at reducing the amount of waste that is produced and eliminating the produced waste without having to dispose of it. This concept also allows businesses to review their production process with the aim of producing only the waste that can be sold which would then allow for the creation of a work environment that embraces minimal environmental pollution and efficient working processes. This promotes the ideals of an Eco-industrial park. Most businesses in the Industrial Parks in Soweto indicated that selling waste would reduce the burden of carrying waste in their working space, while others pointed out that selling the waste that they produce would allow them to grow their business space and also add further departments within their businesses. This concept does not just add value to the businesses and Industrial Parks, but also creates more employment for the communities that these Industrial Parks serve, thereby encouraging the development of an Eco-industrial park, which aims to reduce the concomitant pollution.

5.6 Conclusion

This chapter addressed the sub-objectives of the study and how they were accomplished from the analysis in Chapter 4. The study was able to conclude the following based on these objectives:

- The operations of the Industrial Parks in Soweto have a negative impact on the environment, based on the waste production and lack of waste management.
- There is an appetite and need for Eco-industrial parks in Soweto. This is inferred from the need to sell waste, profit generation and the availability of space to develop the Eco-industrial parks.
- The benefits for developing Eco-industrial parks in Soweto include increased profits for businesses, collaborations and partnerships within the Industrial Park network and with other stakeholders and the sustainability of the eco-system which will further be discussed in chapter 6..
- The application of cleaner production would be possible through the development of Eco-Industrial parks in Soweto, as these would allow business to be environmentally mindful in the production and disposal of the products.

Chapter 6 discusses the proposed framework and its elements. This chapter will provide details of each variable based on the results achieved in Chapter 4.

6. FRAMEWORK DESIGN

6.1 Introduction

This section contains the proposed framework for the development of Eco-industrial parks in Soweto. The framework is based on four principles namely; Organisational principle, Development principle, Sustainability principle and Waste Monitoring and Control principle.

Each of these principles consist of factors and practices that when applied would add value to the development Eco-industrial parks. (See Figure 6.1 below.) The successful application of the Organisational principle leads to stakeholder support, whereas the successful application of the Development principle would lead to business innovation and development. Furthermore, the successful application of the Sustainability principle would lead to business efficiency training and learning, while the successful application of the waste monitoring and control principle would lead to effective waste administration and supervision. All these principles applied together would lead to the successful development of Eco-industrial parks.

FRAMEWORK FOR CLEANER PRODUCTION THROUGH THE DEVELOPMENT OF AN ECO-INDUSTRIAL PARK

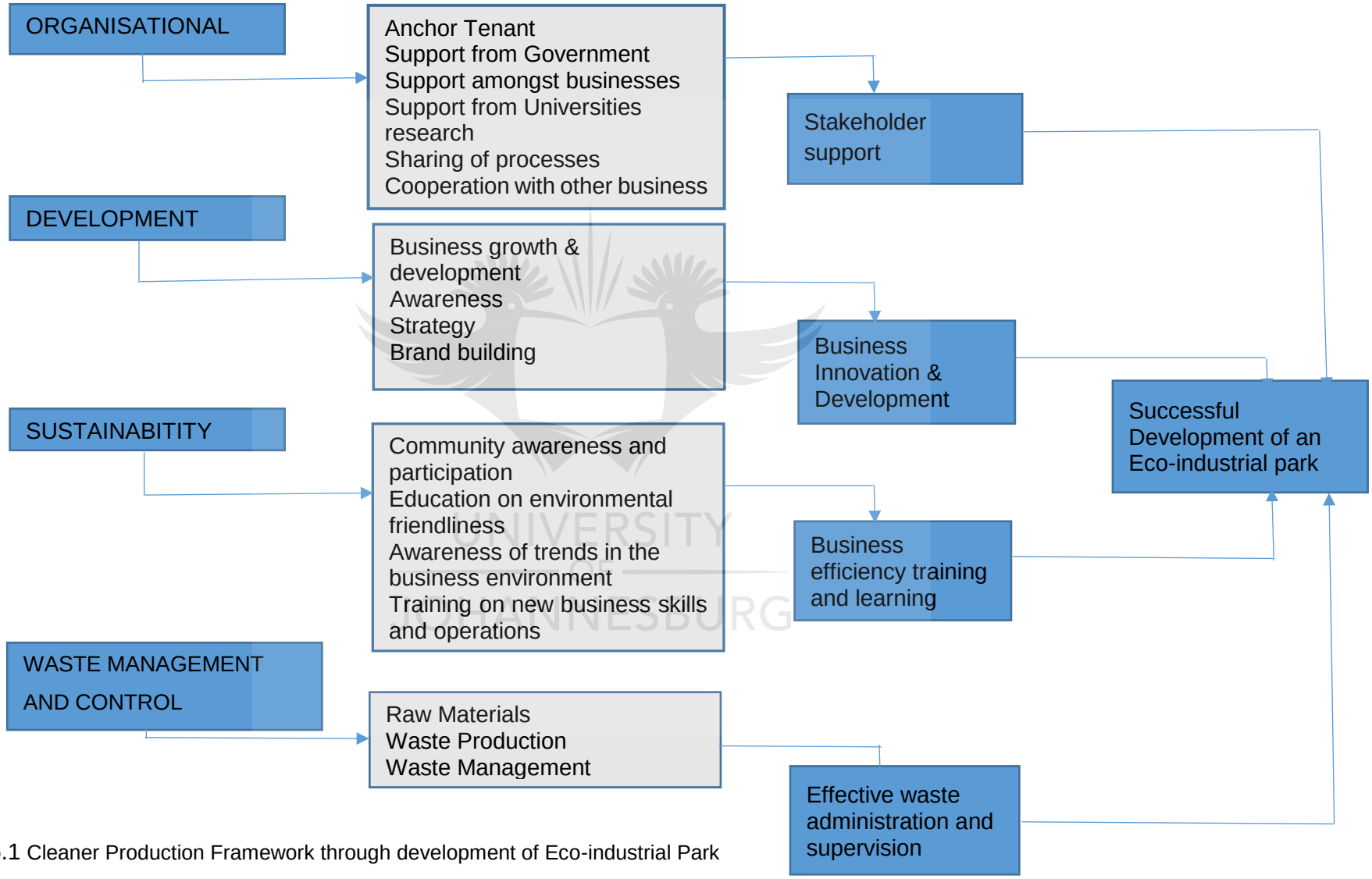

Figure 6.1 Cleaner Production Framework through development of Eco-industrial Park

6.2 Organisational Factors

6.2.1 A business that pulls a lot of customers compared to other businesses in the park: the anchor tenant

A business that pulls a lot of customers compared to other businesses in the industrial park is referred to as an anchor tenant (Tudor *et al*.2007). An anchor tenant is a chief manufacturer in an industrial park, and can provide an continuous waste stream that can be used by surrounding businesses in their manufacturing processes within the industrial park. An anchor tenant is also able to convert information about the existing waste materials into business opportunities for itself and other businesses in the park. The main benefit of an anchor tenant is its reputation with the community that it serves, as this then attracts other businesses to join the park while encouraging existing businesses to join alliances for better production processes and waste management (Behera *et al*. 2012). An anchor tenant greatly contributes to the development of an Eco-industrial park, as it permits new businesses to arise also allowing existing businesses to move into the park.

6.2.2 Support from Government

Support from government is crucial for developing businesses especially those that are in disadvantaged communities such as Soweto. The support that would assist in developing an Eco-industrial park involves coordinative, educational, and infrastructural and financial support (Chertow, 2007). Support from government would enable the businesses within the Industrial Parks to have coordinated systems with regards to waste management which is an integral part of developing an Eco-industrial park (Shi *et al*., 2010). Support from government includes the following characteristics as seen in Figure 6.2 below.

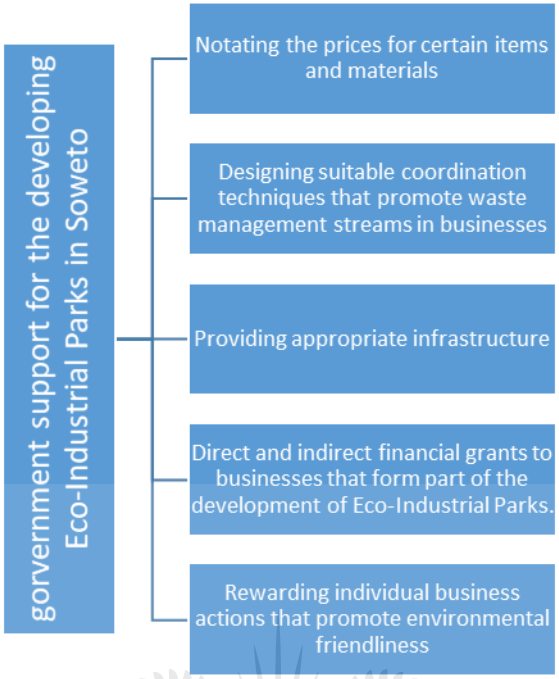

Figure 6.2 Support from government required to develop Eco-industrial parks in Soweto

The required support from government to develop Eco-industrial parks in Soweto is as follows:

- Notating the prices for certain items and materials
- Designing suitable coordination techniques that promote waste management streams in businesses
- Providing appropriate infrastructure
- Direct and indirect financial grants to businesses that form part of the development of Eco-industrial parks.
- Rewarding individual business actions that promote environmental friendliness

6.2.3 **Support amongst businesses in your park**

Businesses in the Industrial Parks need to support each other in terms of sharing information. This allows for businesses to be familiar with each other's waste and by-products produced within the park, which makes it easier for businesses to operate within the park and promotes the very existence of an Eco-industrial park (Milchrahm and Hasler, 2002). Figure 6.3 below indicates the information necessary to be shared within the network.

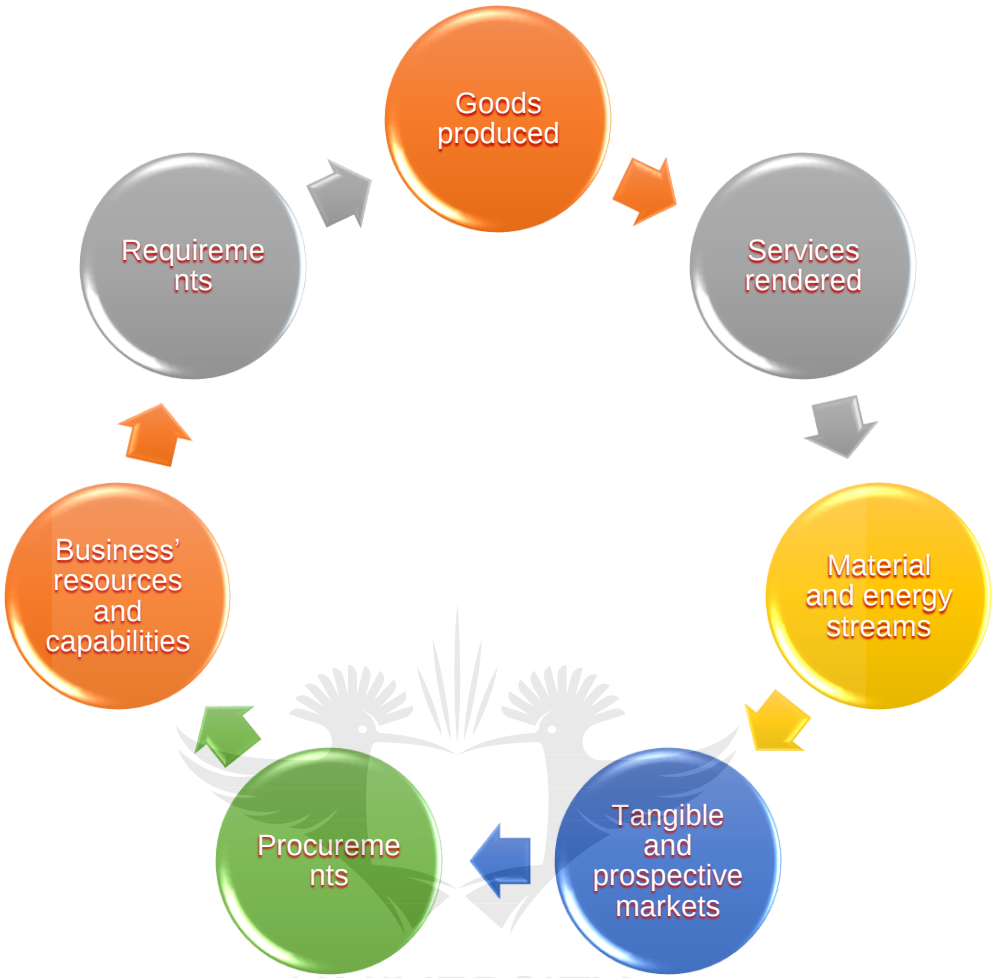

Figure 6.3 Information to be shared in Industrial Park network

The sharing of information enables monitoring of raw materials and waste produced for the entire park and not individual businesses. This knowledge allows businesses to align their needs while taking advantage of the symbiosis, further recognizing the areas to improve performance (Heeres *et al*. 2004). The main information that is necessary to be shared include the following;

- Goods produced
- Services rendered
- Material and energy streams
- Tangible and prospective markets
- Procurements
- Business' resources and capabilities
- Requirements.

6.2.4 **Support from universities and research centres**

Universities and research centres can support Industrial Parks in Soweto through partnerships and providing consulting services.

Local universities within the Gauteng province can collaborate with Industrial Parks where the universities can regularly send interns to the Industrial Parks to work temporarily. This will provide the students with actual experience with entrepreneurs, while allowing the Industrial Park to act as mentors aiming to develop these students in the business world. The universities can also provide affordable short courses to Industrial Parks in the areas of their specialties. This approach would allow the Industrial Parks to access quality knowledge, qualifications and consultation services, while the universities could generate additional income.
Universities are made up of three elements (Scott, 2001) which would benefit the associations with Industrial Parks, namely:

- Normative element.

  This element is concerned with the social beliefs and what is deemed as acceptable and esteemed behaviour, and shared responsibility.
- Cultural-cognitive element.

  This element explores the areas that are indicate the appropriate types of interaction in social settings, these include negotiations, resolutions and classifications.
- Regulative element.

  This is an element of policies, laws and regulations that allow the institution to function within a set system.

The existence of these elements in universities will allow the Industrial Parks to establish principles and operational elements of their own, to allow for a proper functionality of the parks. Norms allow the Industrial Parks to establish what is acceptable practice within the parks. Culture will determine how conflict and negotiations and clustering will be handled within the park, while regulations will provide laws and policies that Industrial Parks will abide by, to ensure fairness and equity within the Industrial Parks.

6.2.5 Sharing of processes with other businesses

6.2.5.1 *By-products exchange*

By-products can be in a form of solid waste, water, energy or air. It is then important for two or more businesses to exchange by-products with the aim of developing an Industrial Symbiosis (Behera 2014).

An Industrial Symbiosis allows businesses to sell and buy by-products from each other within the Industrial Park. These by-products can be used as raw materials by the buyer and further reducing the costs of buying the raw materials directly from the supplier. Chertow (2007) refers to the manifestation of by-product exchange as a kernel for Eco-industrial park, as is provides financial benefits for both the buyer and seller of these.

6.2.6 Good relationships with other businesses

6.2.6.1 *Cooperation*

Good relationships in Industrial Parks are established through cooperation. Cooperation in Industrial Parks means that businesses within the parks would create linkages and dependencies between each other, which ensure successful production and service rendering to the communities. A business in an Industrial Park would normally have relationships with suppliers, customers and other surrounding businesses. It is further necessary that collaborations are also established outside the business operations circle, which includes Universities and Research Centres which would further provide better uses of the businesses' by-products. The relationships formed should be based on mutual trust, transparency, common values and a parallel mindset. (Heeres *et al*. 2004) The Industrial Parks should also consider collaborations with local communities, ecologists, labour representatives and other stakeholders that might have an interest in the development.

6.3 Development Principle

6.3.1 Foreseeing upcoming growth in the business

To survive as a business in an Industrial Park, it is essential that it strives for growth and development (Scott, 2001). Three concepts as indicated in Figure 6.4 below must be considered in growing and developing a business in an Industrial Park.

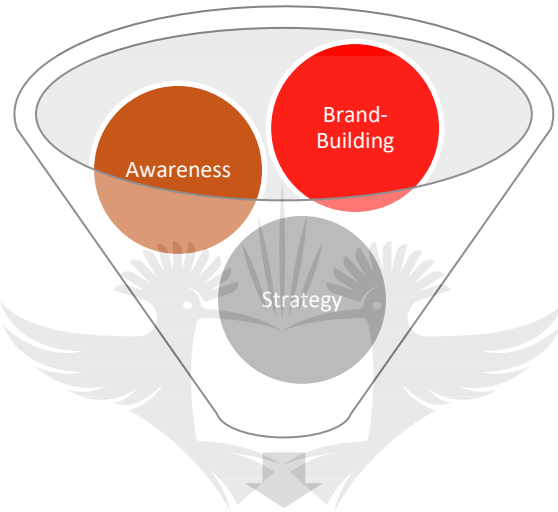

Figure 6.4 Growing a business in an Industrial Park.

6.3.1.1 *Awareness*

Awareness involves being conscious of the audience that the business serves, and having knowledge of what appeals to them, and the tools that can be used to appeal to them best. Awareness also involves identifying the change in the customer trends and preferences and adapting the business tools to fit these trends and preferences.

6.3.1.2 *Strategy*

A business strategy must be dynamic so that it able to evolve as the market evolves. Notwithstanding, it should also be able to lose from the original market. It is essential that a business does not change its strategy based on changing trends, and it is also essential that the strategy developed is dynamic enough to survive market demands.

6.3.1.3 *Building a brand*

Brand-building requires choosing a marketing element, such as an online strategy as blogging. A business requires a brand so that it easier for the audience to recognize and associate with it. The brand has to focus on awareness in content that is displayed, and storytelling to encourage customer association.

To develop an Industrial Park into an Eco-industrial park the following checklist has to be completed in accordance to the National Recycling Forum (NRF, 2018) requirements

- Is there a market for recyclable materials?
- Is there a good supply of recyclable materials?
- What materials do you accept and what don't you accept?
- Do you supply trolleys for collectors?
- Do you supply bags, drums or containers?
- Do we need to clean and sort?
- Can you supply names of local agents or buyers?
- Can you supply addresses of local depots and branches?
- How much do you pay?

The Industrial Park would also need to contact the solid waste department in the local municipality to assess if there are any by-laws or other laws that apply in terms of recycling solid waste, and further information such as licenses, legal documents and permits that are required for compliance.

6.4 Sustainability

6.4.1 Community awareness and participation

Businesses that deal with waste, by-products, scraps and recycling are seen by local communities as problems rather that opportunities (Taddeo *et al*., 2012). It is important for local communities to have a changed view on the establishment of an Eco-industrial park, as they normally have concerns about the possible health and environmental effects (Roberts, 2004).

The Industrial Parks that already exist in Soweto would have to inform the local communities about the benefits of developing an Eco-industrial park through disseminating information locally and involving key stakeholders in the local communities (Shi *et al*. 2010). The information on the benefits of Eco-industrial parks can be distributed through assemblies, consultations, workshops and informative programmes for schools.

6.4.2 Education on environmental friendliness

When developing an Eco-industrial park, it is important for the businesses concerned to be educated on environmental friendliness. This involves landscape protection which is the preservation of the natural environmental and the incorporation of human actions (Francis and Erkman, 2001). According to Yang and Lay (2004) when developing an Eco-industrial park, it is essential that the businesses embrace the landscape ecosystem ideas to reduce the negative ecological effects of urban and industrial development. The businesses would also need to gain insight on environmental compliance regulations and protocols on emissions, pollution and waste management.

6.4.3 Awareness of the new trends in your business environment and Ongoing need to upgrade or develop new products

An industrial park should constantly aim to improve its products and services (Boone 2002). This can be achieved through a 7-step process, indicated in Figure 6.5 below, which involves developing a concept, screening against established criteria, planning a development process, developing a marketing plan, designing the product and service, testing the concept, and continually improving the new product.

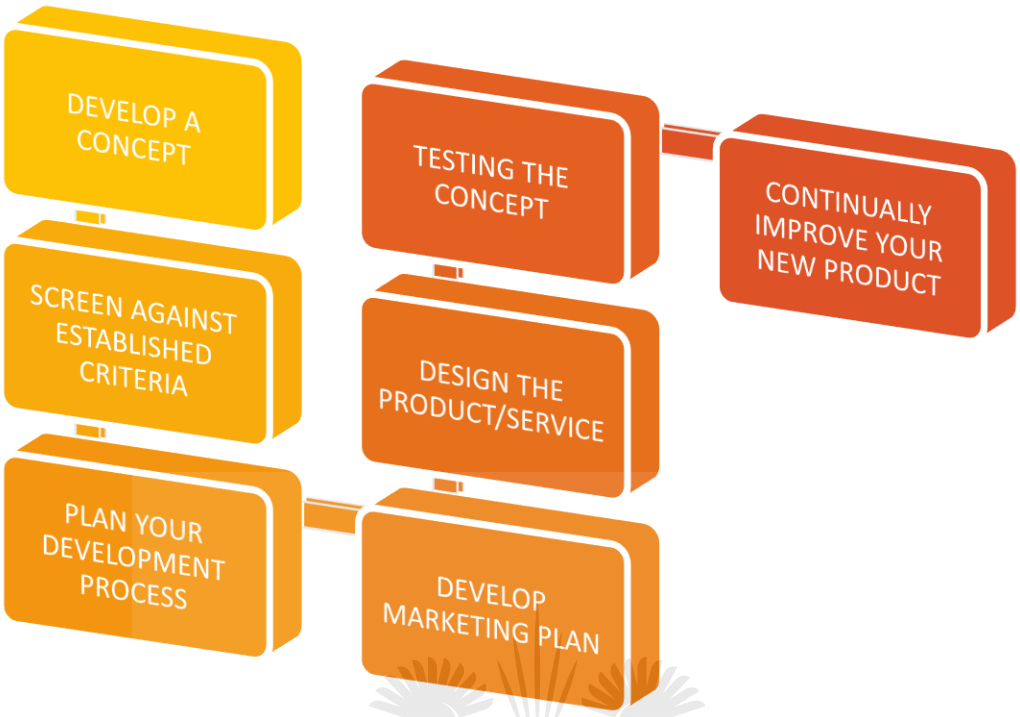

Figure 6.5: Developing a new product and service

1. Developing a concept

Developing a new concept is the first step in developing a new product. This can be done through talking to the customers and understanding what they need. It is best to understand what additional products the customers need from the current products and services that the business already offers. This process requires the involvement of other employees that deal with customers regularly as they would add value in identifying the gap. After identifying the needs of customers, a concept that meets those needs can then be developed. Once the concept is developed both the customers and employees would need to provide feedback and input on the concept, to evaluate whether it will meet the customer's needs.

2. Screening against established criteria

Once the concept is developed, the business would need to assess the following criteria to establish if it is possible to develop the concept further into a product.

- The strength of the business to develop the product
- The business technological abilities
- The business sales and skills capabilities

- Operational boundaries and stowage
- The business financial status, including the debts and the credit
- The reputation of the business
- The preferred market.

3. Plan the development process

The development process for a product requires a schedule to ensure that costs and time is accounted for. A schedule should include the product release date and the estimated amount of time that will be required for every development step. The business will also need to estimate the resources that will be needed to develop the product, this include the working hours and the money that is required to develop the new product. Furthermore, the business will need to develop a budget for the development process, this will assist in sustaining financial responsibilities throughout the development process.

4. Testing the concept

The business would need to test the concept before developing it into a product; this would assist in ensuring that the business develops a product that is market friendly. Testing the concept involves assessing whether it can be produced which is the *technical* feasibility and whether people will buy it, which is the *commercial* feasibility. Technical feasibility involves reviewing the operational capabilities and whether the product performs the way it is designed to perform. Commercial feasibility is concerned with determining product interest and product marketability.

5. Designing the product/service

Based on the success of the technical feasibility testing and the commercial feasibility testing, the product design phase may then commence. The designing of the product includes the product specification. This may involve the products parts for assembly, preparation and instructions. The process of product design is dependent on the product itself.

6. Developing a marketing plan

Developing a marketing plan is essential for the promoting and delivering the product to the market. This process occurs simultaneously with the product design process. A marketing plan involves two phases; the product pricing and product delivery to the market. Product pricing impacts the performance of the product in the market.

This would be determined by the testing phase, as it would also reveal the competitor's prices for

a similar product. Product delivery focuses on how the business plans to get the product into the market, e.g. retailers. This phase also involves ensuring that the employees are sufficiently skilled to ensure that the product or service is delivered appropriately.

7. Continually improve your new product

Once the product is released into the market, it is essential to get feedback from the users to assess the levels of satisfaction and dissatisfaction with the product. A business can conduct surveys or focus groups to get the feedback. The feedback should be used to improve the product, ensuring that it remains competitive and market friendly. The business should always aim to continually improve so that the customer's needs are always satisfied, ensuring the success of the product and thus the business (Boone 2002).

6.4.4 Training on new business skills and operations

Businesses in an Industrial Park would need training on new business skills and operations when aiming at becoming part of an Eco-industrial park (Roberts, 2004). Industrial Park can conduct joint training to ensure that the knowledge distributed is standardized throughout all the businesses in the park. The training should include environmental protection in the product lifecycle, as indicated in Figure 6.6 below.

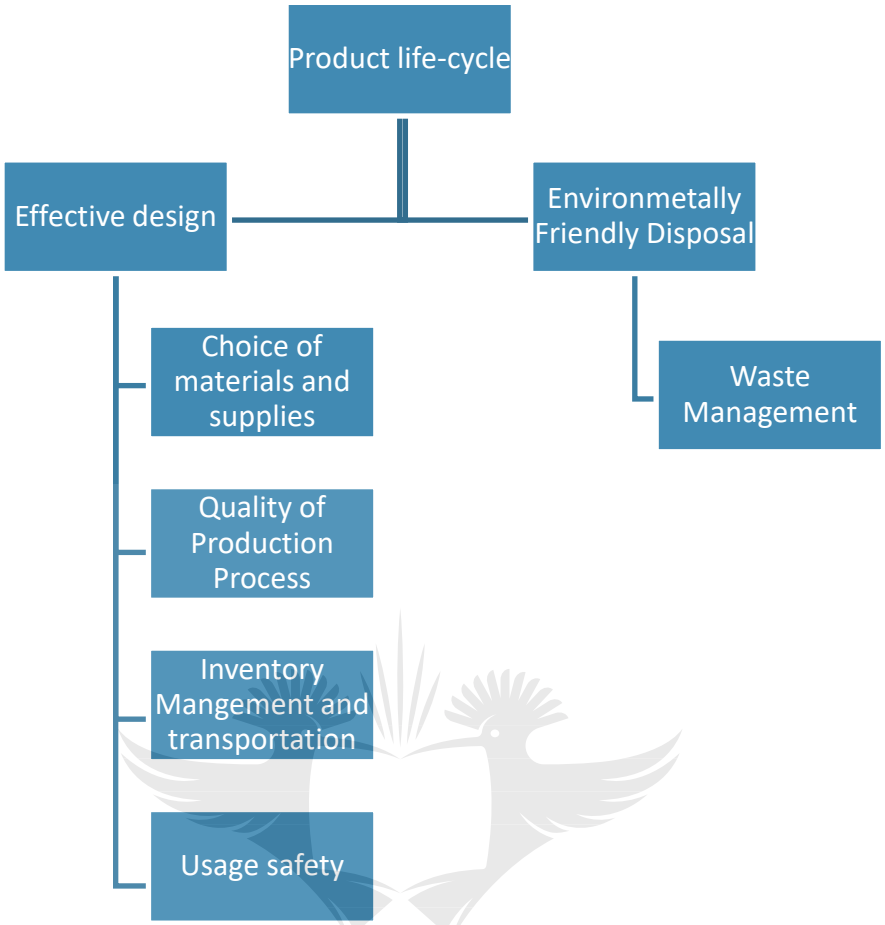

Figure 6.6 Product life cycle

The training material on the product life-cycle and environmental protection should include the product effective design and environmentally friendly disposal techniques (Hussen 2012). Effective product design is concerned with the choice of materials and supplies, quality of production process, inventory management and transportation and usage safety, whereas environmentally friendly design involves waste management principles and applications.

6.5 Waste Monitoring and Control

Waste monitoring and control is the centre of developing an Eco-industrial park. It is essential for Industrial Parks to administer the whole process: the raw materials used, waste production and waste management in their production processes (Boone, 2002), as illustrated in Figure 6.7 below.

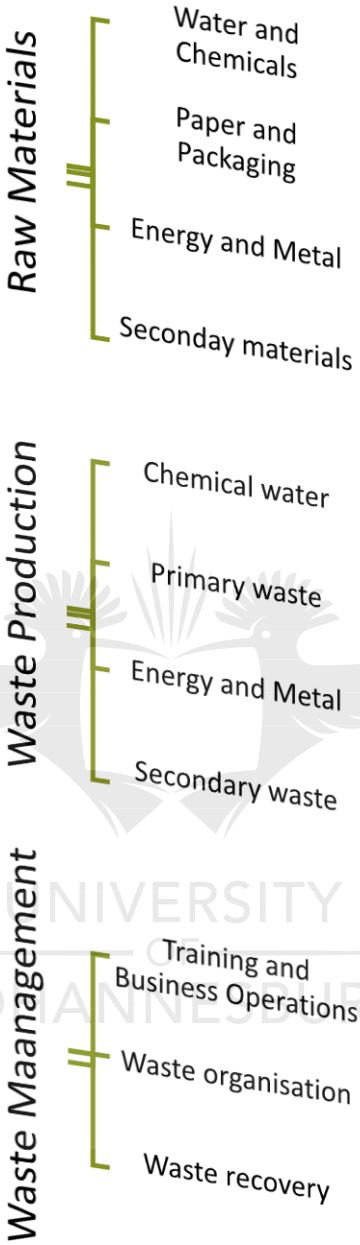

Figure 6.7 Waste Monitoring and Control

6.5.1 Raw materials

Raw materials are concerned with four factors, namely; water and chemicals, paper and packaging, energy and metal, and secondary materials. This is based on the exploratory factor analysis conducted in Chapter 4. Based on the raw material factors, Industrial Parks would have to identify would have classify their raw materials to ensure a standardised identification and recording of raw materials throughout the Park.

6.5.2 Waste production

Waste production, according to the factor analysis in Chapter 4, is concerned with four factors, namely chemical water, primary waste, energy and metal, and secondary waste. The classification of these waste material would also be essential for the standardisation and recording of the waste produced within the park, and this would help in identifying various techniques to manage the waste, and thus promoting the concept of an Eco-industrial park.

6.5.3 Waste management

Waste management deals with the different techniques involved in ensuring that minimal to no waste is disposed of, and that when waste is disposed it does not cause any harm to the environment. Waste management, based on the exploratory factor analysis in Chapter 4, involves three factors: training and business operations, waste organisation and waste recovery. When the waste management practise is explored, based on the exploratory factor analysis in Chapter 4, Industrial Parks have to consider the challenges associated with waste monitoring and controlling. Challenges associated with waste monitoring and controlling have been classified into three factors, namely, manure and sweltering, recycling, training and reduction. These challenges will also be used to classify areas that the Industrial Park would need further training and education to ensure the success in the application, with the aim of managing waste productively (Boone, 2002).

6.6 Conclusion

The proposed framework is aimed at developing Eco-industrial parks in Soweto. The focus of Eco-industrial parks is to ensure that the products and services produced in the Parks is environmentally friendly from the initial product manufacturing to the product disposal phase. This framework introduces the concept of businesses working together in a network, through process sharing, information sharing, and through joint waste-management techniques. This concept allows the parks to innovate and develop their processes and products thus creating a successful Eco-industrial park. The creation of Eco-industrial parks, allows business to apply the culture of cleaner production which aims at sustaining the environment through business operations and processes.

Chapter 7 provides the conclusion for the study. The chapter will provide details on how the objective and sub-objectives of the study have been achieved. The chapter will further address the contribution of the study, the limitations of the study, and the recommendations for future studies.

7. CONCLUSION

7.1 Introduction

This chapter focuses on the objectives and sub-objectives of the study. I discuss how the objective and sub-objectives were achieved. This chapter further provides an overall conclusion of the study, including the limitations of the study, the contribution of the study and the recommendations for future studies. The study finally concludes how this study would impact Soweto and its Industrial Parks.

The main objective of the study was the following: To develop a framework that will assist in the development of Eco-industrial parks in Soweto.

7.2 To evaluate the current environmental impacts of Industrial Parks in Soweto

The study investigated the current environmental impacts through identifying the raw materials that the businesses in the Industrial Parks use to produce their products and the waste that is produced through the use of these raw materials. It was found that the raw materials that are used in Industrial Parks in Soweto, are similar to the waste that is produced. These are as follows; Liquid Chemical, Water, Powder Chemical, Paper, Plastic, Rubber, Steel, Boxes, Fabric, Wood, Glass and Gas. The study found that each of these raw materials and waste products have detrimental impacts to the environment, as explained in Chapter 5. These impacts include, soil, water, air and human beings.

It can therefore be concluded that the Industrial Parks have a negative impact on the environment and that the development of Eco-industrial parks is not only necessary, but also essential for the survival of the eco-system and the sustainability of the environment at large.

7.3 To assess current environmental framework through literature review

The literature review found that there are various frameworks that exist on Industrial Parks; however none of them are based on South Africa. The literature further found that there were gaps that existed. These gaps included few studies focused on formal Industrial Parks and specifically did not cater for informal Industrial Parks. This gap was relevant as most of the Industrial Parks that exist in Soweto are informal. The other gap found was that there was not much research done in South Africa about *developing* Eco-industrial parks. This gap was of concern as it indicated that South Africa is not on par with the rest of the world in developing and operating Eco-industrial parks -- we lag in terms of sustaining the eco-system. The study also found that there are barriers to developing an Eco-industrial park. These barriers have been addressed in the proposed framework in Chapter 6. The framework in Chapter 6 also addressed the gaps that were identified and considered the various frameworks that exist internationally.

7.4 To test appetite for Eco-industrial parks in Soweto

The study tested the appetite for Eco-industrial parks in Soweto by assessing the perceptions of Industrial Parks in terms of buying and selling waste. In Chapter 2, the literature indicated that waste management is a core factor of an Eco-industrial park. The Industrial Parks were assessed on their perceived benefits of buying waste from other businesses in the park, and also their perception of the potential benefits of selling waste to other businesses in the park. It was found that a majority of the businesses preferred selling waste instead of buying waste. The researcher further found that many businesses were unaware of the waste that is available from other businesses in the park that could be of benefit to them. It was also found that the location of the Industrial Parks was favourable in developing Eco-industrial parks, revealing that there is great potential within Soweto to improve the Industrial Parks into Eco-industrial parks.

It can thus be concluded that there is an appetite for Eco-industrial parks in Soweto. Notwithstanding, businesses need to be informed of the various ways to manage waste and also collaborate within the Industrial Park network, ensuring that they have knowledge of what is available within the Industrial Park network and how it can benefit them.

7.5 To develop a novel Eco-industrial park framework for Soweto

The framework developed in Chapter 6, caters specifically for the Industrial Parks in Soweto. The framework was developed based on the results achieved in Chapter 4 and analysed based on the current business operations of the Industrial Parks in Soweto.

The framework consists of four main factors namely; Organisational, Development, Sustainability and the Waste Management factor. When these factors are considered appropriately they would lead to the successful development of an Eco-industrial park.

7.6 To assess potential benefits of developing Eco-industrial parks in Soweto

The potential benefits of developing Eco-industrial parks in Soweto was found through the understanding of how individual businesses can benefit from managing waste. Waste management for Industrial Parks is mainly focused on selling as much waste as a business can while buying waste from the Industrial Park that can benefit the business in developing its own products. The businesses indicated the following examples as potential benefits of developing Eco-industrial parks:

- I can buy damaged crafts and renew them
- I can buy old furniture and renew it for sale
- I can buy old shoes to fix new shoes instead of buying new raw materials
- I can buy old steel metal and renew it
- I can buy rubber soles for cheaper prices
- I can buy wood at a cheaper price
- I can finance my raw materials
- I can get the parts at a cheaper price
- I can grow my business
- I can have more plastics and papers to use for my herbs instead of buying them
- I can open a scrap shop
- I can save money in my raw materials
- I can sell more products from the extra-raw materials
- I can spend less on raw materials

- I can use old fabric for new designs
- I could have raw materials on hand
- I could use old material to train workers instead of new material that is expensive

We can infer then that the potential benefits for developing Eco-industrial parks in Soweto include the ability for businesses to spend less money on raw materials than they currently do, easy access of raw materials, and eventually greater profits for the individual businesses that buy and sell their waste products. The ultimate benefit for developing an Eco-industrial park would be the preservation of the eco-system and the sustainability of the environment due to the reduced level of waste that would be disposed from the Industrial Parks in Soweto.

7.7 Contributions of the study

The development of Eco-industrial parks has evolved internationally. However South Africa, specifically Soweto, has not been introduced to this concept. The study aimed to propose a framework that will enable Soweto Industrial Parks to be on par with other Eco-industrial parks internationally. The framework developed focuses specifically in Soweto, taking into consideration the type of businesses that exist there and the business practices that are specific to Soweto.

The application of the proposed framework would enable the Industrial Parks to form collaborations within the Industrial Park network and with other stakeholders outside the park. The framework would allow the businesses to gain competitive insight and knowledge in their specific business operations. The framework further provides business with the ability to manage their raw materials and waste products in a profitable and environmentally friendly way.

7.8 Limitations of the study

The objective of the study was to propose the development of Eco-industrial parks in Soweto, Gauteng province. It was observed that many of the businesses in the Industrial Parks do not understand the concept of an Eco-industrial park, and therefore are set in their ways.

It was also observed that the concept of waste management seems to apply to formal Industrial Parks in Soweto, though the Informal Industrial Parks lack knowledge in this area. The researcher then had to provide knowledge of these concepts to the businesses to ensure that these limitations were addressed before collecting the data.

7.9 Recommendations for future research

The study recommended that the proposed framework should be implemented to ensure that Industrial Parks in Soweto are developed into Eco-industrial parks. This will ensure the sustainability of the Industrial Parks and also the conservation of the environment.

The study found a number variable that are of concern in the Industrial Park. The study found that the number of female-owned businesses in the Industrial Park is much lower than the male-owned businesses. Future study in the area would explore the lack of women participation in Industrial parks in Soweto. The study also found that approximately 70% of the businesses do not foresee any upcoming growth in their businesses. This factor is concerning as this means that they aim to continue operating as they currently do and also do not aim to innovate or develop any of their products and services. Future research could focus on how to encourage innovation and development in Industrial Parks in Soweto.

7.10 Conclusion

The objective of the study was to propose the development of Eco-industrial parks in Soweto. This objective was met by five sub-objectives. The study identified the environmental impacts of the Industrial Parks by classifying the raw materials and the waste materials produced by the parks. These materials were further analysed to identify the impact of each on the environment. The study also found that the development of Eco-industrial parks was practical in Soweto as the location of the current Industrial Parks was favourable to developing them into Eco-industrial parks, and the keenness of the current Industrial Park businesses to sell and buy waste from each other in the Industrial Park network. The study further developed a detailed and clearly outlined framework that aims to be a guideline on how to develop the current Industrial Parks into Eco-industrial parks specifically in Soweto.

Lastly, the study found that the benefits of developing an Eco-industrial park in Soweto, would allow businesses within the Industrial Parks network to collaborate with each other and with other stakeholders outside the industrial Park network. This will allow the businesses to share processes and gain expertise from each other. These collaborations with also be profitable to the businesses as they will be able to buy their raw materials at lower prices while also selling parts of their materials.

The ultimate benefit for developing Eco-industrial parks is preserving the environment thus enabling cleaner production. These findings indicate that the study was able to satisfy the research objective and sub-objectives.

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9. APPENDICES

9.1 Appendix A: Questionnaire

QUESTIONNAIRE FOR SOWETO INDUSTRIAL PARKS

The University of Johannesburg is undertaking a research project with the purpose to gather information based on how industrial parks are operating in terms of eco-industrial performance. I kindly request you to complete the following short questionnaire based on your business operations. The results of this study will be used in my dissertation for a Doctoral Degree in Engineering Management. The purpose of this survey is to identify: existing resource efficiency initiatives; resource efficiency challenges and opportunities; interest in/support for Eco-industrial park Development; as well as identify the need for capacity building/training interventions.

It should take no longer than 10 minutes of your time. Your response is of the utmost importance to me.

Warmest Regards

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Section A: Business Demographics

1. Gender

Male	Female

2. Age

18 -24	25 -31	32-38	39-45	46 and above

3. Highest Qualification

Grade 11 or Lower (Std 9 or lower)	
Grade 12 (Matric, Std 10)	
Post matric Diploma or Certificate	
Baccalaureate Degree(s)	
Post Graduate Degree (s)	

4. Indicate the type of business you are running.

NAME	TICK APPROPRIATE BOX.
Craft	
Traditional medicine	
Spaza shop	
Street vendor	
Metal work	
Hair Dressing and Nails	
Shebeen	
Mechanics	
Clothing and Textile	
Tyre sales and repairs	
Cobbler	
Wholesale	
Tile and flooring	
Carpenter	
Other……	

5. How long has this business been operating? [YEARS]

0 – 3		3 - 6		6 - 9		9 - 12		12 and above	

Section B: Objectives and Literature

6. Select the structure that best describes your business

Type of organization	Manufacturing		Service	
Structure of the business	Formal		Informal	

7. List the raw materials you use in your business.

Raw Materials	Never	Seldom	Sometimes	Often	Always
1. Rubber					
2. Plastic					
3. Steel					
4. Paper					
5. Glass					
6. Wood					
7. Boxes					
8. Fabric					
9. Gas					
10. Water					
11 Liquid Chemical					
12. Powder Chemical					
13. Other. Please specify:					

8. What type of waste does your business produce?

Raw Materials	Never	Seldom	Sometimes	Often	Always
1. Rubber					
2. Plastic					
3. Steel					
4. Paper					
5. Glass					
6. Wood					
7. Boxes					

8. Fabric					
9. Gas					
10. Water					
11 Liquid Chemical					
12. Powder Chemical					
13. Other. Please specify:					

9. Does your Business face the following challenges with regard to managing waste?

	Never	Seldom	Sometimes	Often	Always
1. Reducing waste					
2. Waste removal					
3. Waste treatment					
4. Recycling waste					
5. Reusing waste					
6. Recovering Waste					
7. Waste Incineration					
8. Storage of waste (before disposal or removal)					
9. Education and training (on how to deal with different types of waste)					
10. Selling waste to other businesses					
11. Other. please specify:					

10. Do you think your business should do the following to reduce waste produced?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Recycle					
2. Reuse					
3. Recover					
4. Open Burning					
5. Incineration					
6. Make Compost					

7. Bury					
8. Dump waste					
9. Obtain training on how to reduce waste					
10. Sell waste to other businesses or individuals					
11. Other:					

11. Do you recycle any of your waste produced by your business?

Yes	No

12. (**if you answered YES above**) how much of your business overall waste is recycled? (select one)

100%		25% to 50%	
75% or more		Less than 25%	
50% to 75%			

13. Organisational: Do you have following in your industrial park?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. A business that pulls a lot of customers compared to other businesses in the park					
2. Support from Government					
3. Support amongst businesses in your park					
4. Support from universities and research centers					
5. Sharing of processes with other businesses					
6. Buildings (working area) in good condition					
7. Good relationships with other businesses					

14. Do you foresee any upcoming growth in your business?

Yes	No

15. (If YES above) please explain

……

……

……..

16. Sustainability: Do you have the following in your industrial park?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Community awareness and participation					
2. Education on environmental friendliness					
3. Awareness of the new trends in your business environment					
4. Ongoing need to upgrade or develop new products					
5. Training on new business skills and operations					

17. Do you think your business can benefit from buying waste from other businesses in the park?

Yes	No

(If YES above), Please explain.

……

……

18. Do you think your business can benefit from selling waste to other businesses in the park?

Yes	No

(If YES above), Please explain

……

……

19. Do you currently buy or sell any waste that your business produces?

No, I Don't Buy or Sell Waste.	Yes, I BUY and SELL waste produced.	I ONLY SELL the waste that I produce in my business	I ONLY BUY waste produced by other businesses in the park.

20. Are you aware of any businesses that buy or sell their waste from or to other businesses in your park?

No, there are no businesses that buy or sell waste	Yes, there are businesses that sell their waste	Yes, there are businesses that buy waste	I don't know

21. Would you be interested in buying and (or) selling waste produced in your business?

No, I would not be interested in either Buying or Selling waste	Yes, interested in ONLY SELLING waste produced by my business	Yes, interested in ONLY BUYING waste produced by my business	Yes, would be interested in BOTH BUYING and SELLING of the waste produced by my business

22. What waste do you think your business can sell to another business in the park? List.

……

……..

23. Do you know what an Eco-industrial park is?

Yes	No

24. Do you think your current location is a good space to develop an environmentally friendly (green) business park?

Yes	No

Thank you for your participation…

9.2 Appendix B: Statistics

Frequency Table					
Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	106	76,3	76,8	76,8
	Female	32	23,0	23,2	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		
Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 -24	3	2,2	2,2	2,2
	25 -31	25	18,0	18,1	20,3
	32-38	40	28,8	29,0	49,3
	39-45	46	33,1	33,3	82,6
	46 and above	24	17,3	17,4	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		
Highest Qualification					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Grade 11 or Lower (Std 9 or lower)	23	16,5	17,2	17,2
	Grade 12 (Matric,	27	19,4	20,1	37,3

	Std 10)				
	Post matric Diploma or Certificate	36	25,9	26,9	64,2
	Baccalaureate Degree(s)	22	15,8	16,4	80,6
	Postgraduate Degree (s)	26	18,7	19,4	100,0
	Total	134	96,4	100,0	
Missing	System	5	3,6		
Total		139	100,0		
Indicate the type of business you are running.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Craft	10	7,2	7,2	7,2
	Traditional medicine	6	4,3	4,3	11,5
	Spaza shop	5	3,6	3,6	15,1
	Street vendor	4	2,9	2,9	18,0
	Metal work	17	12,2	12,2	30,2
	Hair Dressing and Nails	10	7,2	7,2	37,4
	Shebeen	9	6,5	6,5	43,9
	Mechanics	15	10,8	10,8	54,7
	Clothing and Textile	9	6,5	6,5	61,2
	Tyre sales and repairs	10	7,2	7,2	68,3
	Cobbler	6	4,3	4,3	72,7
	Wholesale	3	2,2	2,2	74,8
	Tile and flooring	6	4,3	4,3	79,1
	Carpenter	9	6,5	6,5	85,6
	Other	20	14,4	14,4	100,0
	Total	139	100,0	100,0	
Please specify:					

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No response	119	85,6	85,6	85,6
	Bakery	1	0,7	0,7	86,3
	Big bags manufacturer	1	0,7	0,7	87,1
	Butchery	1	0,7	0,7	87,8
	Car wash	1	0,7	0,7	88,5
	Chicken farm	1	0,7	0,7	89,2
	Cooking shop	1	0,7	0,7	89,9
	Digital media	1	0,7	0,7	90,6
	Dog houses manufacturer	1	0,7	0,7	91,4
	Dry cleaners	1	0,7	0,7	92,1
	Foam mattress	1	0,7	0,7	92,8
	Foam mattress manufacturer	1	0,7	0,7	93,5
	Fridge repairers	1	0,7	0,7	94,2
	Glass manufacturer	1	0,7	0,7	95,0
	Liquid soap manufacturer	1	0,7	0,7	95,7
	Paint manufacturer	1	0,7	0,7	96,4
	Paper manufacturer	1	0,7	0,7	97,1
	Plastic manufacturer	1	0,7	0,7	97,8
	Tag manufacturer	1	0,7	0,7	98,6
	Tombstone manufacturer	1	0,7	0,7	99,3
	Upholstery	1	0,7	0,7	100,0
	Total	139	100,0	100,0	

How long has this business been operating? [YEARS]

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 – 3	18	12,9	12,9	12,9

	3 - 6	28	20,1	20,1	33,1
	6 - 9	44	31,7	31,7	64,7
	9 - 12	28	20,1	20,1	84,9
	12 and above	21	15,1	15,1	100,0
	Total	139	100,0	100,0	
Type of organization					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	84	60,4	63,2	63,2
	Service	49	35,3	36,8	100,0
	Total	133	95,7	100,0	
Missing	System	6	4,3		
Total		139	100,0		
Structure of the business					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Formal	53	38,1	43,1	43,1
	Informal	70	50,4	56,9	100,0
	Total	123	88,5	100,0	
Missing	System	16	11,5		
Total		139	100,0		
		Never	Seldom	Sometimes	Often
Rubber	Count	41	29	21	31
	Row N %	29,5%	20,9%	15,1%	22,3%
Plastic	Count	36	35	20	18
	Row N %	25,9%	25,2%	14,4%	12,9%
Steel	Count	61	11	24	14
	Row N %	43,9%	7,9%	17,3%	10,1%
Paper	Count	23	37	26	33

	Row N %	16,5%	26,6%	18,7%	23,7%
Glass	Count	84	30	13	4
	Row N %	60,4%	21,6%	9,4%	2,9%
Wood	Count	93	5	13	10
	Row N %	66,9%	3,6%	9,4%	7,2%
Boxes	Count	88	14	7	12
	Row N %	63,3%	10,1%	5,0%	8,6%
Fabric	Count	97	7	5	12
	Row N %	69,8%	5,0%	3,6%	8,6%
Gas	Count	105	6	10	11
	Row N %	77,2%	4,4%	7,4%	8,1%
Water	Count	25	9	36	41
	Row N %	18,0%	6,5%	25,9%	29,5%
Liquid Chemical	Count	20	5	6	55
	Row N %	14,6%	3,6%	4,4%	40,1%
Powder Chemical	Count	35	25	22	19
	Row N %	25,2%	18,0%	15,8%	13,7%
Other	Count	12	0	1	6
	Row N %	27,3%	0,0%	2,3%	13,6%
Descriptive Statistics					
	N	Mean	Std. Deviation		
Liquid Chemical	137	3,82	1,362		
Other	44	3,73	1,744		
Water	139	3,27	1,350		
Powder Chemical	139	3,00	1,560		
Paper	139	2,93	1,322		
Plastic	139	2,79	1,501		
Rubber	139	2,67	1,416		
Steel	139	2,56	1,611		
Boxes	139	1,98	1,486		

Wood	139	1,96	1,493		
Fabric	139	1,90	1,500		
Glass	139	1,72	1,123		
Gas	136	1,55	1,114		
Valid N (listwise)	39				
Frequencies					

Please specify:

		Frequency	Percent	Valid Percent	Cumula-tive Percent
Valid		114	82,0	82,0	82,0
	Alcohol	1	0,7	0,7	82,7
	Beads	1	0,7	0,7	83,5
	Beer	1	0,7	0,7	84,2
	Bottles	1	0,7	0,7	84,9
	Cans	1	0,7	0,7	85,6
	Cement	3	2,2	2,2	87,8
	Chickens	1	0,7	0,7	88,5
	Crates	1	0,7	0,7	89,2
	Flour	1	0,7	0,7	89,9
	Foam	1	0,7	0,7	90,6
	Foam seats	1	0,7	0,7	91,4
	Herbs	3	2,2	2,2	93,5
	Leather	2	1,4	1,4	95,0
	Meat	1	0,7	0,7	95,7
	Poultry	1	0,7	0,7	96,4
	Sand	1	0,7	0,7	97,1
	Vegetables	2	1,4	1,4	98,6
	Wood cream	1	0,7	0,7	99,3
	Zinc	1	0,7	0,7	100,0
	Total	139	100,0	100,0	

Custom Tables					
		Never	Seldom	Sometimes	Often
Rubber	Count	57	37	12	19
	Row N %	41,0%	26,6%	8,6%	13,7%
Plastic	Count	46	40	17	13
	Row N %	33,1%	28,8%	12,2%	9,4%
Steel	Count	75	14	10	15
	Row N %	54,0%	10,1%	7,2%	10,8%
Paper	Count	43	33	32	17
	Row N %	30,9%	23,7%	23,0%	12,2%
Glass	Count	99	23	9	5
	Row N %	71,7%	16,7%	6,5%	3,6%
Wood	Count	101	3	13	6
	Row N %	72,7%	2,2%	9,4%	4,3%
Boxes	Count	90	18	8	12
	Row N %	64,7%	12,9%	5,8%	8,6%
Fabric	Count	100	13	3	5
	Row N %	73,0%	9,5%	2,2%	3,6%
Gas	Count	119	5	10	5
	Row N %	85,6%	3,6%	7,2%	3,6%
Water	Count	31	24	41	29
	Row N %	22,3%	17,3%	29,5%	20,9%
Liquid Chemical	Count	28	19	24	41
	Row N %	20,1%	13,7%	17,3%	29,5%
Powder Chemical	Count	50	34	15	20
	Row N %	36,0%	24,5%	10,8%	14,4%
Other	Count	10	4	0	8
	Row N %	25,0%	10,0%	0,0%	20,0%
Descriptive Statistics					

	N	Mean	Std. Deviation		
Other	40	3,50	1,710		
Liquid Chemical	139	3,14	1,417		
Water	139	2,79	1,282		
Plastic	139	2,47	1,451		
Powder Chemical	139	2,47	1,461		
Paper	139	2,47	1,315		
Steel	139	2,29	1,612		
Rubber	139	2,25	1,378		
Boxes	139	1,82	1,320		
Wood	139	1,80	1,415		
Fabric	137	1,72	1,372		
Glass	138	1,46	0,881		
Gas	139	1,29	0,754		
Valid N (listwise)	40				

Please specify:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		118	84,9	84,9	84,9
	Beer cans beer bottles	1	0,7	0,7	85,6
	Bottles	1	0,7	0,7	86,3
	Can bottles	1	0,7	0,7	87,1
	Cans	1	0,7	0,7	87,8
	Chicken fat	1	0,7	0,7	88,5
	Chicken feathers and chicken pieces	1	0,7	0,7	89,2
	Crates	1	0,7	0,7	89,9
	Cream	1	0,7	0,7	90,6
	Damaged vegetables	1	0,7	0,7	91,4
	Fat bones animal fur	1	0,7	0,7	92,1
	Foam	1	0,7	0,7	92,8

	Foam pieces	1	0,7	0,7	93,5
	Granite	1	0,7	0,7	94,2
	Herbs	1	0,7	0,7	95,0
	Leather	2	1,4	1,4	96,4
	Mixed cement	1	0,7	0,7	97,1
	Paste	1	0,7	0,7	97,8
	Plants	1	0,7	0,7	98,6
	Tiles	1	0,7	0,7	99,3
	Zinc	1	0,7	0,7	100,0
	Total	139	100,0	100,0	
Custom Tables					
		Never	Seldom	Sometimes	Often
Reducing waste	Count	34	21	7	45
	Row N %	24,5%	15,1%	5,0%	32,4%
Waste removal	Count	12	17	16	47
	Row N %	8,6%	12,2%	11,5%	33,8%
Waste treatment	Count	18	24	23	43
	Row N %	12,9%	17,3%	16,5%	30,9%
Recycling waste	Count	15	11	24	60
	Row N %	10,8%	7,9%	17,3%	43,2%
Reusing waste	Count	15	8	33	44
	Row N %	10,8%	5,8%	23,7%	31,7%
Recovering Waste	Count	22	14	34	38
	Row N %	16,1%	10,2%	24,8%	27,7%
Waste Incineration	Count	70	17	17	19
	Row N %	50,7%	12,3%	12,3%	13,8%
Storage of waste (before disposal or removal)	Count	15	19	27	37
	Row N %	10,9%	13,8%	19,6%	26,8%
Education and	Count	17	30	26	49

training (on how to deal with different types of waste)	Row N %	12,2%	21,6%	18,7%	35,3%
Selling waste to other businesses	Count	20	33	19	41
	Row N %	14,4%	23,7%	13,7%	29,5%
Other	Count	9	0	3	8
	Row N %	40,9%	0,0%	13,6%	36,4%
Descriptive Statistics					
	N	Mean	Std. Deviation		
Waste Incineration	138	2,22	1,459		
Other	22	2,73	1,549		
Education and training (on how to deal with different types of waste)	139	3,14	1,241		
Reducing waste	139	3,14	1,540		
Selling waste to other businesses	139	3,14	1,360		
Recovering waste	137	3,28	1,343		
Waste treatment	139	3,32	1,342		
Storage of waste (before disposal or removal)	138	3,49	1,330		
Recycling waste	139	3,55	1,217		
Reusing waste	139	3,60	1,255		
Waste removal	139	3,72	1,286		
Valid N (listwise)	22				
Please specify:					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		138	99,3	99,3	99,3

	Waste conversion	1	0,7	0,7	100,0
	Total	139	100,0	100,0	
Custom Tables					
		Strongly Agree	Agree	Neutral	Disagree
Recycle	Count	81	51	1	4
	Row N %	58,7%	37,0%	0,7%	2,9%
Reuse	Count	51	71	7	6
	Row N %	37,0%	51,4%	5,1%	4,3%
Recover	Count	45	61	16	11
	Row N %	32,6%	44,2%	11,6%	8,0%
Open Burning	Count	43	36	16	29
	Row N %	31,4%	26,3%	11,7%	21,2%
Incineration	Count	35	27	20	24
	Row N %	25,4%	19,6%	14,5%	17,4%
Make Compost	Count	19	34	30	37
	Row N %	14,0%	25,0%	22,1%	27,2%
Bury	Count	23	29	34	39
	Row N %	16,8%	21,2%	24,8%	28,5%
Dump waste	Count	21	26	36	30
	Row N %	15,6%	19,3%	26,7%	22,2%
Obtain training on how to reduce waste	Count	22	54	26	22
	Row N %	15,9%	39,1%	18,8%	15,9%
Sell waste to other businesses or individuals	Count	32	58	18	16
	Row N %	23,9%	43,3%	13,4%	11,9%
Other:	Count	16	9	0	2
	Row N %	59,3%	33,3%	0,0%	7,4%
Descriptive Statistics					
	N	Mean	Std.		

			Deviation		
Dump waste	135	3,04	1,304		
Make Compost	136	2,98	1,250		
Incineration	138	2,93	1,525		
Bury	137	2,91	1,234		
Obtain training on how to reduce waste	138	2,65	1,218		
Open burning	137	2,51	1,373		
Sell waste to other businesses or individuals	134	2,36	1,185		
Recover	138	2,06	1,045		
Reuse	138	1,83	0,876		
Other:	27	1,56	0,847		
Recycle	138	1,50	0,727		
Valid N (listwise)	24				
Frequency Table					
Do you recycle any of your waste produced by your business?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	75	54,0	55,1	55,1
	No	61	43,9	44,9	100,0
	Total	136	97,8	100,0	
Missing	System	3	2,2		
Total		139	100,0		
How much of your business overall waste is recycled?					
		Frequency	Percent	Valid Percent	Cumulative Percent

Valid	100%	1	0,7	1,3	1,3
	75% or more	10	7,2	13,3	14,7
	50% to 75%	15	10,8	20,0	34,7
	25% to 50%	18	12,9	24,0	58,7
	Less than 25%	31	22,3	41,3	100,0
	Total	75	54,0	100,0	
Missing	System	64	46,0		
Total		139	100,0		
		Strongly Agree	Agree	Neutral	Disagree
A business that pulls a lot of customers compared to other businesses in the park	Count	40	65	2	25
	Row N %	29,0%	47,1%	1,4%	18,1%
Support from Government	Count	6	31	14	46
	Row N %	4,3%	22,5%	10,1%	33,3%
Support amongst businesses in your park	Count	10	45	31	39
	Row N %	7,4%	33,3%	23,0%	28,9%
Support from universities and research centres	Count	10	21	19	48
	Row N %	7,3%	15,3%	13,9%	35,0%
Sharing of processes with other businesses	Count	7	38	44	30
	Row N %	5,1%	27,9%	32,4%	22,1%
Buildings (working area) in good condition	Count	13	43	23	33
	Row N %	9,4%	31,2%	16,7%	23,9%
Good relationships with other businesses	Count	31	41	22	18
	Row N %	22,5%	29,7%	15,9%	13,0%

Descriptive Statistics					
	N	Mean	Std. Deviation		
A business that pulls a lot of customers compared to other businesses in the park	138	2,22	1,176		
Good relationships with other businesses	138	2,76	1,427		
Support amongst businesses in your park	135	2,96	1,105		
Sharing of processes with other businesses	136	3,09	1,099		
Buildings (working area) in good condition	138	3,12	1,296		
Support from government	138	3,62	1,246		
Support from universities and research centres	137	3,62	1,249		
How much of your business overall waste is recycled?	75	3,91	1,129		
Valid N (listwise)	71				
Frequency Table					
Do you foresee any upcoming growth in your business?					

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	35	25,2	25,7	25,7
	No	101	72,7	74,3	100,0
	Total	136	97,8	100,0	
Missing	System	3	2,2		
Total		139	100,0		
Please explain					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		120	86,3	86,3	86,3
	I am adding 4 more tables and 16 more chairs from 1st December	1	0,7	0,7	87,1
	I am building a braai area outside my butchery	1	0,7	0,7	87,8
	I am opening a new branch in a different location	1	0,7	0,7	88,5
	I am opening a new store in Katlehong in the East Rand	1	0,7	0,7	89,2
	I have applied for a contract to supply a cleaning company	1	0,7	0,7	89,9
	I hope to open a new division for low cost material in my business	1	0,7	0,7	90,6

	I just bought 3 new machines and I am currently training people to use them	1	0,7	0,7	91,4
	I normally employ an extra worker during peak seasons like December holidays	1	0,7	0,7	92,1
	I plan on extending my working hours to accommodate the festive season demand	1	0,7	0,7	92,8
	I plan to create more products in the coming 6months to take to exhibitions for a sale	1	0,7	0,7	93,5
	I plan to hire 2more mechanics in the next 6 months	1	0,7	0,7	94,2
	I want to create more crafts and sell more than I currently do	1	0,7	0,7	95,0
	I want to train and employ a temporary hairdresser in December	1	0,7	0,7	95,7
	I am extending my store to add more shelves for the bakery section	1	0,7	0,7	96,4

	I am extending my working space no accommodate new products	1	0,7	0,7	97,1
	I am in the process to add vegetables to my stock	1	0,7	0,7	97,8
	I am receiving training on making storage boxes which I plan also to sell	1	0,7	0,7	98,6
	We are opening a new branch in the Johannesburg CBD	1	0,7	0,7	99,3
	We are starting to make wooden tiles in January 2019	1	0,7	0,7	100,0
	Total	139	100,0	100,0	
Custom Tables					
		Strongly Agree	Agree	Neutral	Disagree
Community awareness and participation	Count	37	73	3	16
	Row N %	26,8%	52,9%	2,2%	11,6%
Education on environmental friendliness	Count	18	32	18	34
	Row N %	13,0%	23,2%	13,0%	24,6%
Awareness of the new trends in your business environment	Count	14	37	25	46
	Row N %	10,1%	26,8%	18,1%	33,3%
Ongoing need to	Count	27	31	22	36

upgrade or develop new products	Row N %	19,6%	22,5%	15,9%	26,1%
Training on new business skills and operations	Count	19	36	21	32
	Row N %	13,8%	26,1%	15,2%	23,2%
Descriptive Statistics					
	N	Mean	Std. Deviation		
Education on environmental friendliness	138	3,28	1,408		
Training on new business skills and operations	138	3,13	1,382		
Awareness of the new trends in your business environment	138	3,09	1,214		
Ongoing need to upgrade or develop new products	138	2,96	1,385		
Community awareness and participation	138	2,18	1,148		
Valid N (listwise)	138				
Frequency Table					
Do you think your business can benefit from buying waste from other businesses in the park?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	55	39,6	39,9	39,9

	No	83	59,7	60,1	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		
Please explain.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		103	74,1	74,1	74,1
	I buy empty bottles from households	1	0,7	0,7	74,8
	I buy old couches and fix and resell them at a better price	1	0,7	0,7	75,5
	I buy old metal and renew it	1	0,7	0,7	76,3
	I buy old plastic products from domestic household transform and sell them	1	0,7	0,7	77,0
	I buy old tyres	2	1,4	1,4	78,4
	I buy old tyres to fix new ones	1	0,7	0,7	79,1
	I buy old wood to make my crafts	1	0,7	0,7	79,9
	I buy used wood	1	0,7	0,7	80,6
	I buy wood from tree cutters to make my products	1	0,7	0,7	81,3
	I can buy damaged crafts and renew them	1	0,7	0,7	82,0
	I can buy old furniture	1	0,7	0,7	82,7

	and renew it for sale				
	I can buy old shoes to fix new shoes instead of buying new raw materials	1	0,7	0,7	83,5
	I can buy old steel metal and renew it	1	0,7	0,7	84,2
	I can buy rubber soles for cheaper prices	1	0,7	0,7	84,9
	I can buy wood at a cheaper price	1	0,7	0,7	85,6
	I can finance my raw materials	1	0,7	0,7	86,3
	I can get the parts at a cheaper price	1	0,7	0,7	87,1
	I can grow my business	1	0,7	0,7	87,8
	I can have more plastics and papers to use for my herbs instead of buying them	1	0,7	0,7	88,5
	I can open a scrap shop	1	0,7	0,7	89,2
	I can save money in my raw materials	1	0,7	0,7	89,9
	I can sell more products from the extra-raw materials	1	0,7	0,7	90,6
	I can spend less on raw materials	1	0,7	0,7	91,4
	I can use old fabric for new designs	1	0,7	0,7	92,1

	I could have more raw materials on hand	1	0,7	0,7	92,8
	I could use old material to train workers instead of new material that is expensive	1	0,7	0,7	93,5
	I currently buy empty bottles and plastics	1	0,7	0,7	94,2
	I use old metal to make new products	1	0,7	0,7	95,0
	I will buy cheaper parts fix them and resell them	1	0,7	0,7	95,7
	I would be able to access more metal	1	0,7	0,7	96,4
	I would have a lot more raw materials	1	0,7	0,7	97,1
	I am not sure how I will benefit	1	0,7	0,7	97,8
	It would give me an opportunity to interact with other mechanics	1	0,7	0,7	98,6
	It would make it easier to get metal	1	0,7	0,7	99,3
	We use torn tyres to repair	1	0,7	0,7	100,0
	Total	139	100,0	100,0	

Do you think your business can benefit from selling waste to other businesses in the park?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	81	58,3	59,1	59,1

	No	56	40,3	40,9	100,0
	Total	137	98,6	100,0	
Missing	System	2	1,4		
Total		139	100,0		
Please explain					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		77	55,4	55,4	55,4
	By selling cans I make money for my business and get discount on my stock	1	0,7	0,7	56,1
	I can be able to buy more machinery in my business	1	0,7	0,7	56,8
	I can be able to order more stock for my stock	1	0,7	0,7	57,6
	I can buy old car batteries and renew them	1	0,7	0,7	58,3
	I can employ more people to assist with the workload	1	0,7	0,7	59,0
	I can employ more workers during the festive season	1	0,7	0,7	59,7
	I can finance other things I need in my store	1	0,7	0,7	60,4
	I can generate more income in my	1	0,7	0,7	61,2

	business				
	I can get rid of the broken tiles at a price	1	0,7	0,7	61,9
	I can have a new stream of income	1	0,7	0,7	62,6
	I can hire more people to do the work	1	0,7	0,7	63,3
	I can hire someone to sell the waste and pay them from it	1	0,7	0,7	64,0
	I can make extra money for my business	1	0,7	0,7	64,7
	I can make money from selling broken car parts	1	0,7	0,7	65,5
	I can make money from the pieces don't use	1	0,7	0,7	66,2
	I can make more money in my business	1	0,7	0,7	66,9
	I can open a waste department	1	0,7	0,7	67,6
	I can open a new waste department	1	0,7	0,7	68,3
	I can reduce waste the waste I need to remove	1	0,7	0,7	69,1
	I can remove the excess waste on my premises	1	0,7	0,7	69,8
	I can sell leftover wood instead of	1	0,7	0,7	70,5

	burning it				
	I can sell my scrap metal parts and make additional money	1	0,7	0,7	71,2
	I can sell my tyre pieces and make more money	1	0,7	0,7	71,9
	I can sell my waste and clean up my premises	1	0,7	0,7	72,7
	I can sell the leftover foam to the other upcoming business and create a collaboration with them	1	0,7	0,7	73,4
	I can sell the scrap that I normally throw away	1	0,7	0,7	74,1
	I can use any means of extra income in my business	1	0,7	0,7	74,8
	I can use my waste as an income generator	1	0,7	0,7	75,5
	I could sell them at a cheaper price and make money for my business	1	0,7	0,7	76,3
	I exchange old parts for cash to buy new parts	1	0,7	0,7	77,0

	I give away my waste it would be an advantage to sell it	1	0,7	0,7	77,7
	I have damaged plastic bottles that are piling up space	1	0,7	0,7	78,4
	I have fabric that I don't know what to do with that is left over from other products	1	0,7	0,7	79,1
	I normally throw away left over material selling it would be a good substitute	1	0,7	0,7	79,9
	I sell beer bottles and cans to make extra money	1	0,7	0,7	80,6
	I sell broken car parts to the scrap-yard	1	0,7	0,7	81,3
	I sell cans and bottles that I collect from cars to Pikit Up	1	0,7	0,7	82,0
	I sell empty bottles to the bottle store	1	0,7	0,7	82,7
	I sell plastic that cannot be re melted	1	0,7	0,7	83,5
	I sometimes sell zinc leftovers to people in the camps to patch their roofs	1	0,7	0,7	84,2
	I will be able to remove the containers in my premises by	1	0,7	0,7	84,9

	selling them				
	I would be able to grow my business	1	0,7	0,7	85,6
	I would be able to buy second hand car parts cheaper	1	0,7	0,7	86,3
	I would be able to expand my operations	1	0,7	0,7	87,1
	I would be able to remove some of the waste from my premises	1	0,7	0,7	87,8
	I would be able to sell more things in my business	1	0,7	0,7	88,5
	I would like to make more money in my business	1	0,7	0,7	89,2
	I would sell instead of dumping it	1	0,7	0,7	89,9
	Instead of storing and burning boxes I can sell them	1	0,7	0,7	90,6
	Instead of storing it can sell it	1	0,7	0,7	91,4
	It can generate more money in my business	1	0,7	0,7	92,1
	It can help finance my new branch	1	0,7	0,7	92,8
	It can help us deal with the high volume of glass waste	1	0,7	0,7	93,5

	produced				
	It would help the business financially in this current economic climate	1	0,7	0,7	94,2
	It would reduce the attraction of thieves in my business	1	0,7	0,7	95,0
	It would reduce the bad smell	1	0,7	0,7	95,7
	It would reduce the waste that I have to store before removal	1	0,7	0,7	96,4
	It would reduce the waste that is stored on my premises	1	0,7	0,7	97,1
	Sometimes we don't know what to do with some of the waste selling it would help us keep our premises clean	1	0,7	0,7	97,8
	We could hire more administration staff members	1	0,7	0,7	98,6
	We have a lot of waste on the premises and it increases during municipal strikes I would appreciate any new initiative that	1	0,7	0,7	99,3

	would help me reduce it				
	We sell our waste to pawn shop	1	0,7	0,7	100,0
	Total	139	100,0	100,0	
Do you currently buy or sell any waste that your business produces?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No, I Don't Buy or Sell Waste.	107	77,0	77,5	77,5
	Yes, I BUY and SELL waste produced.	3	2,2	2,2	79,7
	I ONLY SELL the waste that I produce in my business	9	6,5	6,5	86,2
	I ONLY BUY waste produced by other businesses in the park.	19	13,7	13,8	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		
Are you aware of any businesses that buy or sell their waste from or to other businesses in your park?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No, there are no businesses that buy	32	23,0	23,2	23,2

	or sell waste				
	Yes, there are businesses that sell their waste	37	26,6	26,8	50,0
	Yes, there are businesses that buy waste	36	25,9	26,1	76,1
	I don't know	33	23,7	23,9	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		

Would you be interested in buying and (or) selling waste produced in your business?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No, I would not be interested in either Buying or Selling waste	37	26,6	26,8	26,8
	Yes, interested in ONLY SELLING waste produced by my business	49	35,3	35,5	62,3
	Yes, interested in ONLY BUYING waste produced by my business	20	14,4	14,5	76,8
	Yes, would be interested in BOTH BUYING and SELLING of the waste	32	23,0	23,2	100,0

	produced by my business				
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		

What waste do you think your business can sell to another business in the park? List.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		21	15,1	15,1	15,1
	Animal fat and bone pieces	1	0,7	0,7	15,8
	Beads and fabric pieces	1	0,7	0,7	16,5
	Beer bottles and cans	1	0,7	0,7	17,3
	Beer cans and bottles	1	0,7	0,7	18,0
	Bottles and cans	2	1,4	1,4	19,4
	Bottles and nuts fan belts	1	0,7	0,7	20,1
	Boxes	3	2,2	2,2	22,3
	Boxes plastics	2	1,4	1,4	23,7
	Boxes rotten vegetables	1	0,7	0,7	24,5
	Broken car parts	1	0,7	0,7	25,2
	Broken car parts	2	1,4	1,4	26,6
	Broken damaged glass	1	0,7	0,7	27,3
	Broken tiles	2	1,4	1,4	28,8
	cans and bottles	1	0,7	0,7	29,5
	Cans and bottles	1	0,7	0,7	30,2
	Car parts	1	0,7	0,7	30,9

	Car parts that are broken	1	0,7	0,7	31,7
	Car parts that don't work	1	0,7	0,7	32,4
	Cement broken damaged tiles	1	0,7	0,7	33,1
	Cement damaged tiles	1	0,7	0,7	33,8
	Chicken fat uncooked	1	0,7	0,7	34,5
	Chicken feathers	1	0,7	0,7	35,3
	Containers	1	0,7	0,7	36,0
	Cut fabric	1	0,7	0,7	36,7
	Damaged crafts	2	1,4	1,4	38,1
	Damaged crafts wood leftover	1	0,7	0,7	38,8
	Damaged tyres	1	0,7	0,7	39,6
	Different sizes of boxes	2	1,4	1,4	41,0
	Dried herbs	1	0,7	0,7	41,7
	Empty bottles and cans	1	0,7	0,7	42,4
	Empty containers	1	0,7	0,7	43,2
	Empty plastic containers	1	0,7	0,7	43,9
	Fabric	3	2,2	2,2	46,0
	Fabric for sewing	1	0,7	0,7	46,8
	Fabric material	1	0,7	0,7	47,5
	Fabric pieces	2	1,4	1,4	48,9
	Flopped cakes	1	0,7	0,7	49,6
	Foam	1	0,7	0,7	50,4
	Foam fabric	1	0,7	0,7	51,1
	Foam pieces	1	0,7	0,7	51,8
	Foam wood fabric	1	0,7	0,7	52,5

	leather				
	Granite by product	1	0,7	0,7	53,2
	Herbs raw unmixed	1	0,7	0,7	54,0
	I am not sure	1	0,7	0,7	54,7
	I am not sure what I can sell as waste	1	0,7	0,7	55,4
	I don't have anything to sell	1	0,7	0,7	56,1
	I don't know	2	1,4	1,4	57,6
	I don't think I can sell any of my waste	1	0,7	0,7	58,3
	I am not sure	1	0,7	0,7	59,0
	Left-over fabric	1	0,7	0,7	59,7
	Maybe leather pieces	1	0,7	0,7	60,4
	Metal	1	0,7	0,7	61,2
	Metal parts	1	0,7	0,7	61,9
	Metal pieces	2	1,4	1,4	63,3
	Metal pots	1	0,7	0,7	64,0
	Metal scrap	1	0,7	0,7	64,7
	Mixed cement	1	0,7	0,7	65,5
	Mixed cement tiles	1	0,7	0,7	66,2
	Old car parts	2	1,4	1,4	67,6
	Old fridge parts	1	0,7	0,7	68,3
	Old metal and left-over metal pieces	1	0,7	0,7	69,1
	Old shoe sales	1	0,7	0,7	69,8
	Old shoes	1	0,7	0,7	70,5
	Old shoes soles	1	0,7	0,7	71,2
	Old shoes that cannot be repaired	1	0,7	0,7	71,9
	Old tyre pieces	1	0,7	0,7	72,7
	Plastic nails cut	1	0,7	0,7	73,4
	Paper	2	1,4	1,4	74,8

	Paper towels	1	0,7	0,7	75,5
	Plants that grow alongside my herbs	1	0,7	0,7	76,3
	Plastic bottles	1	0,7	0,7	77,0
	Plastic fabric chemicals metal	1	0,7	0,7	77,7
	Plastic products	1	0,7	0,7	78,4
	Plastics	1	0,7	0,7	79,1
	Plastics and plastic containers	1	0,7	0,7	79,9
	Plastics and soap water	1	0,7	0,7	80,6
	Plastics paper boxes	1	0,7	0,7	81,3
	Rotten wilded fruits and vegetables	1	0,7	0,7	82,0
	Rubber	2	1,4	1,4	83,5
	Scrap car parts	1	0,7	0,7	84,2
	Scrap parts	1	0,7	0,7	84,9
	Small wood pieces	1	0,7	0,7	85,6
	Steel metal	1	0,7	0,7	86,3
	Steel pieces	1	0,7	0,7	87,1
	Torn shoes	1	0,7	0,7	87,8
	Tyre parts	1	0,7	0,7	88,5
	Tyre pieces	1	0,7	0,7	89,2
	Tyre pieces parts	1	0,7	0,7	89,9
	Uncut metal pieces	1	0,7	0,7	90,6
	Unmixed herbs plants	1	0,7	0,7	91,4
	Withered plants	1	0,7	0,7	92,1
	Wood	3	2,2	2,2	94,2
	Wood and metal pieces	1	0,7	0,7	95,0
	Wood parts	3	2,2	2,2	97,1
	Wood pieces	2	1,4	1,4	98,6

	Wood uncut	1	0,7	0,7	99,3
	Wood zinc	1	0,7	0,7	100,0
	Total	139	100,0	100,0	
Do you know what an Eco-industrial park is?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	53	38,1	38,4	38,4
	No	85	61,2	61,6	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		
Do you think your current location is a good space to develop an environmentally friendly (green) business park?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	105	75,5	76,1	76,1
	No	33	23,7	23,9	100,0
	Total	138	99,3	100,0	
Missing	System	1	0,7		
Total		139	100,0		